Ameren Missouri CoolSavers Impact and Process Evaluation: Program Year 2013

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EXECUTIVE SUMMARY

Ameren Missouri (Ameren) engaged the Cadmus team (composed of Cadmus and Nexant) to perform annual process and impact evaluations of the CoolSavers program for a three-year period from 2013 through 2015. This annual report covers the impact and process evaluation findings for Program Year 2013 (PY13), the period from January 1, 2013, through December 31, 2013.

Program Description

CoolSavers offers Ameren customers living in single-family homes, condos, or townhomes incentives for installing high-efficiency central air conditioners (CAC) or heat pumps (HP) through a participating program contractor. The program also offers incentives for:

- Diagnostic testing and tuning of existing HVAC systems to manufacturer specifications;
- Installing variable-speed fan motors; and
- Installing programmable thermostats.

CoolSavers is implemented by ICF International (ICF).

Key Impact Evaluation Findings

This section presents the Cadmus team's key impact findings for PY13.

Gross Impacts

Through the metering of 161 participating CoolSavers systems, we estimated the per-unit gross energy savings shown in Table 1. We calculated measure-specific realization rates as the ratio of Ameren's *ex ante* savings from its Technical Resource Manual (TRM) and our team's evaluated (*ex post*) savings, and we then determined a gross savings realization rate of 86.4% for the CoolSavers program as a whole. Two measures had realization rates below 50%: (1) HVAC systems receiving condenser cleaning or evaporator cleaning; and (2) programmable thermostats. However, HVAC systems receiving refrigerant charge adjustment and ground-source HPs had realizations rates well over 100%.

Table 1. PY13 Participation, Per-Unit *Ex Post* Gross Savings, Realization Rate

Measure	PY13 Participation	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings (kWh/yr)
HPs				
Air Source HP—Early Replacement of Air Source HP*	362	5,491	115.7%	1,987,723
Air Source HP—Early Replacement of Electric Furnace*	311	14,896	96.3%	4,632,629
Air Source HP—Replace at failure of Air Source HP*	50	1,444	92.4%	72,182
Air Source HP—Replace at failure of Electric Furnace*	36	13,575	97.9%	488,699
Ground Source HP	84	28,014	183%	2,353,150
CACs				
CAC—Early Replacement*	5,593	1,822	88%	10,189,116
CAC—Replace on Burnout*	302	364	70%	109,975
Diagnostic Tune-Up				
HVAC Systems Receiving Condenser Cleaning**	3,194	230	44.7%	736,059
HVAC Systems Receiving Refrigerant Charge Adjustment**	502	687	359.4%	344,623
HVAC Systems Receiving Evaporator Cleaning**	256	183	28.7%	46,825
HVAC Systems Receiving General Maintenance	68	174	100.0%	11,825
Electronically Commutated Motor (ECM)				
ECM Installed with AHRI Rated HVAC System	4,670	767	83%	3,582,554
ECM Installed (not in conjunction with HVAC system)	234	738	79%	172,620
Programmable Thermostat				
Thermostat Installed with Setback Programmed	4,473	82.72	15%	370,016
Total	**20,135**	**n/a**	**86.4%**	**25,097,995**

*Combined incentive tiers (SEER 14, SEER 15, SEER 16).
**Savings adjusted assuming 10% of tune-ups were ASHPs which have additional savings in heating mode.

Net Savings

To estimate CoolSavers PY13 net-to-gross (NTG) ratios, the Cadmus team used the following formula:

NTG = 1.0 – Free Ridership + Participant Spillover + Nonparticipant Spillover + Market Effects

For the PY13 evaluation, we estimated the first three NTG elements, but not market effects. Since the program is likely to generate market effects—program staff will work closely with local contractors and distributors to improve installation and stocking practices—we plan to estimate the market effect as part of the PY14 evaluation.

As shown in Table 2, the Cadmus team determined an overall weighted NTG of 95.4% for the CoolSavers program, attributed to three main findings:

- Free ridership for new HVAC installations, estimated as 23%, was determined by analyzing responses from participant and contractors surveys (decrement to NTG).
- Participant spillover (other non-HVAC actions undertaken by CoolSavers participants) was at 1.4% (increase to NTG).
- The NPSO generated by Ameren's and ICF's substantial investment in CoolSavers-specific marketing (approximately $825,000) was 19.2% (increase to NTG).

Table 2. PY13 Net Impact Results Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	NPSO	NTG Ratio	Net Savings (kWh/yr)*
HPs	9,534,384	27%	1.4%	19.2%	93.4%	8,905,523
CACs	10,299,090	23%			97.6%	10,051,912
Diagnostic Tune-Up	1,139,332	37%			84.0%	957,039
ECMs	3,755,173	23%			97.6%	3,665,049
Programmable T-Stats	370,016	23%			97.6%	361,135
Program Total	**25,097,995**				95.4%	**23,940,658**

*Overall program precision at the 90% confidence interval is 16.3%. This combines confidence and precision (C/P) from metered energy consumption and savings with C/P from NTG surveys.

As shown in Table 3, due to higher-than-expected participation, the program achieved 138% of its proposed net energy savings target for PY13 (17,218 MWh) in Ameren's residential tariff approved by the Missouri Public Service Commission (MPSC). The program achieved 112% of its proposed net demand savings target for PY13 (12,361 kW).

Table 3. PY13 Savings Comparisons

Metric	MPSC-Approved Target[1]	*Ex Ante* Gross Savings Utility Reported[2]	*Ex Post* Gross Savings Determined by EM&V[3]	*Ex Post* Net Savings Determined by EM&V[4]	Percent of Goal Achieved[5]
Energy (MWh)	17,218	27,876	25,098	23,941	139%
Demand (kW)	12,361	9,826	14.502	13,833	112%

[1] https://www.ameren.com/sites/AUE/Rates/Documents/UECSheet191EEResidential.pdf

[2] Calculated by applying tracked program activity to TRM savings values.

[3] Calculated by applying tracked program activity to Cadmus' evaluated savings values.

[4] Calculated by multiplying Cadmus' evaluated gross savings and NTG ratio, which accounts for free ridership, participant spillover, nonparticipant spillover, and market effects.

[5] Compares MPSC Approved Target and *Ex Post* Net Savings Determined by EM&V

Key Process Evaluation Findings

Program stakeholders reported the following challenges as they ramped up the program in PY13: cooler-than-anticipated weather (which tempered early participation); data quality concerns regarding contractor's reported measurements; and a longer-than-anticipated launch. Despite these issues, the new program design resulted in attracting three times the number of contractor participants as the CheckMe!® Plus program (last offered in PY11). It currently has 400 participating contractors, which is 80% of the CoolSavers' goal of 500. ICF also was able to eliminate (or ease) some of the early concerns that contractors had about data reporting and measure eligibility.

Participation also increased from the prior CheckMe! program years. Specifically, CoolSavers incented more tune-ups in eight months than were incented under the CheckMe!, which operated for nearly two years.

Ameren and ICF noted the importance of hiring a dedicated local program manager for the CoolSavers program. Ameren anticipated ICF would have hired a dedicated program manager by the spring; however, ICF did not fill the role until after the busy summer months.

Participating contractors generally are satisfied with the program incentives amounts and data collection requirements of the program. Program participants (home owners) also expressed satisfaction with the program and their contractors.

Key Conclusions and Recommendations

Based on the preceding findings, the Cadmus team presents the following CoolSavers conclusions and recommendations.

Conclusion 1. New systems are installed correctly and use relatively low energy. Furthermore, our analysis showed participating contractors properly sized most systems. Our analysis yielded per-unit

gross savings realization rates between 70% and 116% for most measures. This indicates the program's *ex ante* values were reasonable but could be slightly refined.

> **Recommendation 1. Adopt the *ex post* savings values and continue to maintain the commissioning requirements of new HVAC installations.**

Conclusion 2. Contractors did not report reliable SEER estimates of old systems replaced through the early replacement incentive. To evaluate the program, we had to adjust reported SEER values to develop a reasonable baseline for early replacement measures.

> **Recommendation 2. The CoolSavers implementation team should prioritize** its plan to test the operating efficiency of a sample of existing systems prior to early replacement, which will improve confidence in the baseline value.

Conclusion 3. In general, the requirements of the CoolSavers tune-up program are sufficient, but the data reported by contractors should be improved. Specifically, the Cadmus team identified issues with 30% of the reported tune-up measurements (issues described in "Tuned-Up Systems" evaluation section), which significantly reduced the sample size of Energy Efficiency Rating (EER) measurements available to our team for estimating savings.

> **Recommendation 3. ICF should continue to provide training, mentoring, and relatively quick feedback for contractors who provide incomplete or erroneous data.** We also recommend ICF work with the Cadmus team to develop standard protocols for approving and reporting EER values used to estimate savings.

Conclusion 4. Numerous contractors reported it is cost-effective for customers to install an HP with a gas backup furnace. The current HP measure precludes HPs with gas backup heat from receiving program incentives. According to interviewed contractors, this preclusion is limiting program participation and savings. HPs with gas backup heat might have higher electric savings potential than a CAC replace-on-failure measure because contractors might recommend the installation of a federal minimum-efficiency HP with a gas backup furnace.

> **Recommendation 4. Amend the measure requirements to allow HPs with gas backup heat with an appropriate incentive offering.**

Conclusion 5. Contractors seem satisfied with the program requirements and incentives offered for tune-ups. However, ICF structured the tune-up incentive so any HVAC system can receive a tune-up. This means some systems receive an incentive for a service that is unnecessary and generates no savings. For example, our review of tune-up participant data found that only about 15% of systems received refrigerant charge adjustments. We understand, through our interviews with participating contractors and program managers, that significant changes to the program's tune-up design might be detrimental to program participation.

Recommendation 5. Leave the tune-up protocol and incentive offering largely unchanged, but consider a slight modification to the incentive structure. To increase participation, Ameren could, for example, offer $65 for a tune-up that does not require a refrigerant charge adjustment and $85 for a tune-up that requires a refrigerant charge adjustment. This change could provide these benefits:

- Help offset the cost of additional refrigerant;
- Not deter contractors from participating; and
- Encourage contractors to look for units with lower-operating efficiency.

Conclusion 6. HVAC systems on annual maintenance agreements might have less savings potential than systems that have not received yearly service. We conducted phone surveys and determined which tune-up participants had existing maintenance agreements and which did not. We reviewed the savings for each group and found participants without maintenance agreements had higher average savings. However the uncertainty of this analysis is high due to small the sample size (40 with plans, 34 without, and three were unsure).

Recommendation 6. Require contractors to report whether the tuned-up system was covered under an existing maintenance agreement[1] for every system serviced to enable analysis of the differences between these types of participants with improved confidence. For additional detail and specific information we suggest contractors collect, see APPENDIX G. ADDITIONAL CONCLUSIONS.

Conclusion 7. Free ridership was similar to or lower than other HVAC programs, but changes could reduce it further.

Recommendation 7. Reduce free ridership by performing targeted marketing that addresses the following:

- Identify and solicit customers with high electric heating and electric cooling loads (identified through billing analysis) using bill stuffers or other mechanisms. This will allow ICF to target customers with wasteful energy habits or with inefficient HVAC systems.

Conclusion 8. There is low participation in co-op marketing program, and the program implementer faces a challenge in addressing inconsistent and/or incorrect use of the Ameren logo and brand.

Recommendation 8. Since contractors are a major channel for customer outreach, consider development of a formal co-op marketing package or toolkit for distribution to participating contractors.

[1] A maintenance agreement is a yearly service plan. This is generally an agreement between resident and contractor wherein the contractor checks and cleans the HVAC system each year for a set price.

Conclusion 9. The program has realized success in targeting customers based on the propensity data, as found through the summer "cooling" campaign.

> **Recommendation 9.** Continue to target customers for this program (and others, as applicable), based on propensity modeling.

INTRODUCTION

Ameren engaged the Cadmus evaluation team to perform a process evaluation and an impact evaluation of the CoolSavers program for a three-year period. This annual report covers the impact and process evaluation findings for Program Year 2013 (PY13), the period from January 1, 2013, through December 31, 2013.

Program Description

CoolSavers offers Ameren customers living in single-family homes, condos, or townhomes incentives for installing high-efficiency central air conditioners (CAC) or heat pumps (HP) through a participating program contractor. The program also offers incentives for:

- Tuning an existing HVAC system to manufacturer specifications;
- Installing variable-speed fan motors; and
- Installing programmable thermostats.

To participate, a residential customer must have a measure installation performed by a participating contractor listed on Ameren's Website.[2] The participating contractor submits all required paperwork for incentive processing. To become a participating contractor, an HVAC company representative only needs to attend a program training session conducted by the implementer, ICF International (ICF).

Program Activity

In PY13, the CoolSavers program had 9,260 participants who received a total of 20,135 rebates (many of the program participants received multiple rebates). Table 4 provides summaries for the three main measure types and includes the percentage of HVAC system installations that entailed electronically commutated motor (ECMs) and programmable T-stats.[3]

Table 4. CoolSavers PY13 Program Activity

Measure	Number of Systems/Measures	Homes Receiving More Than One of This Measure	Homes Receiving Programmable T-Stat Incentive	% Receiving ECM Incentive
Air Source HPs	843	6.2%	59.4%	79.6%
CACs	5,895	6.1%	65.2%	68.3%
Tune-Ups*	3,681	22.1%	0.5%	0.8%

*Does not match quantity total in Table 1 because some systems received multiple tune-up measures.

[2] http://www.ameren.com/sites/AUE/MyHome/ResEfficiency/Pages/EnergyEfficiencyLookup.aspx

[3] Although ECMs and programmable thermostats are separate measures, these were typically part of an HVAC system installation. A programmable thermostat installed on its own would is installed through rebate savers. More than 95% of ECMs were installed with an HVAC system.

EVALUATION METHODOLOGY

In evaluating Ameren's CoolSavers program, the Cadmus team identified the following objectives for PY13.

Impact Evaluation Priorities

- Technical resource manual (TRM) review;
- Meter new and tuned-up HVAC systems to produce estimates of HVAC consumption and savings, particularly for early-season behaviors;
- Verify the accuracy of contractors' reported measurements and the accuracy of efficiency improvements, estimated through calculations performed by the provided tools (ICF refers to their calculation tool as 'The Optimizer');
- Examine savings from variable-speed fan motors and programmable thermostats;
- Examine duct sealing program potential;
- Weather-normalize results using accepted Missouri weather-normalization techniques; and
- Assess free ridership, spillover, and long-term market effects to calculate net savings.

Process Evaluation Priorities

- Assess the impacts of program design changes, marketing activities, and program processes;
- Assess the program's achievements against goals;
- Examine participants' experiences, satisfaction with various program design elements, and decision-making motivations;
- Identify primary market barriers, and offer suggestions for effectively overcoming barriers through program design and delivery improvements;
- Assess any indications of market change, and establish baselines for longitudinal assessments of local standard installation practices; and
- Track CoolSavers' ability to interact with other Ameren programs.

Table 5 lists the evaluation activities conducted in PY13 to reach the above objectives, followed by a brief summary of each activity.

Table 5.PY13 Process and Impact Evaluation Activities and Rationale

Evaluation Activity	Process	Impact	Rationale
Review the TRM		•	Review TRM values and assumptions and then conduct engineering analysis to provide updated information for future program years.
Review the Tracking Data	•	•	Provide ongoing support to ensure all necessary program data are tracked accurately; identify gaps for evaluation, measurement, and verification (EM&V) purposes.
Review Marketing Materials	•		Identify gaps and opportunities in the program's marketing and outreach strategies and activities.
Interview Stakeholders	•		Obtain an in-depth understanding of the program and identify its successes and challenges.
Survey Participants (phone)	•	•	Verify measure installation; collect data to inform net-to-gross (NTG) ratio; collect process related data and resident satisfaction.
Interview Participating Contractors	•	•	Program delivery, communication with contractors and NTG data.
Site Visits and Metering		•	Verify measure installation and HVAC system diagnostic data reported. Metering of tune-up and new systems and duct leakage tests.
Conduct an Engineering Analysis		•	Determine gross kWh savings for each measure.
Conduct a Cost-Effectiveness Analysis		•	Measure the cost-effectiveness of the program through five standard perspectives: total resource cost, utility cost, societal cost test, participant cost test, and ratepayer impact test.

TRM Review

At the outset of the PY13 evaluation, the Cadmus team reviewed the algorithms used by Ameren (which were specified in its TRM for CoolSavers measures) and the algorithms in other TRMs for similar measures. Early in the program year, we benchmarked each measure's algorithm, assumptions, and savings against those from other TRMs. We then attempted to identify differences between the values Ameren assumed in the TRM and the values that may result from the formal evaluation process. Our goals included: (1) to enhance our understanding of the specific measures that Ameren's implementer was delivering; and (2) to provide early feedback that could potentially allow Ameren's implementer to make mid-year course corrections for improving program delivery.

Data Tracking Review

In conjunction with the TRM review, the Cadmus team reviewed the program tracking database (Vision) used by ICF. Specifically, we assessed whether ICF was gathering the data necessary for an accurate

evaluation and for use with the algorithms detailed in the Ameren TRM. Because of the timing of our review—which included an assessment of data quality and completeness—we were able to notify Ameren and its implementer early in the program about the issues we observed.

ICF provided two databases: Vision, the program's online reporting database, and The OCC Savings database, an Excel file used to track diagnostic tune-up data from each tune-up performed.

- The Vision database, which was updated weekly, contains information such as:
  - Incentive amount
  - Measure type
  - Customer information
  - New HVAC Equipment information
  - Existing (replaced) equipment information
- The OCC savings database, which is transmitted electronically, is a database containing diagnostic information regarding program tune-ups, and it tracks the following information:
  - Qualitative information about the work performed (e.g. refrigerant was adjusted, condenser was cleaned)
  - Pre and post HVAC cooling capacity
  - Pre and post HVAC system power
  - HVAC system size

Marketing Review

In mid-2013, the Cadmus team reviewed the CoolSavers marketing materials. To enhance our understanding of the marketing planning, coordination, and outreach efforts, we also interviewed key marketing staff from ICF. Our assessment considered all aspects of the program marketing, such as: strategy development, processes and planning, goals and objectives, target audience, messaging, marketing tactics, and metrics. We then synthesized our findings to assess the program's ability to: (1) reach the identified customer segments; and (2) efficiently generate program participation.

In a memorandum submitted to Ameren and ICF on November 13, 2013, we provided our initial feedback regarding the effectiveness of the program's marketing effort. This report includes: information from that memo; and our conclusions and recommendations for improving the program's overall marketing approach.

Stakeholder Interviews

For the CoolSavers PY13 evaluation, the Cadmus team interviewed Ameren and ICF program managers, as shown in Table 6. We completed the first wave early in PY13 to assess the program's launch and the second late in the year to learn about any adjustments to ICF and Ameren's delivery. We designed these interviews to: (1) gather information on how effectively the program is operating; (2) identify the

challenges encountered by program staff and the implementer; and (3) determine appropriate solutions. (A copy of our interview guide is provided in Appendix B.)

Table 6. Completed Stakeholder Interviews

Stakeholder Group	Interviews Conducted
Ameren Missouri Program Staff	1
ICF Program Management	2
Total	**3**

Participant Surveys

In PY13, the Cadmus team conducted two telephone surveys of CoolSavers participants and completed a total of 153 surveys, as shown in Table 7. Our surveys covered topics for both the impact evaluation and the process evaluation, including: measure verification, free ridership, spillover, participant awareness and decision making, and satisfaction. (Copies of our survey instruments are provided in Appendix C.)

Table 7.CoolSavers Participant Survey Summary

Target Audience	Survey Method	Field Dates	Completed Surveys
Replacement Participants	Phone	11/20-11/23	79
Tune-up Participants	Phone	11/20-11/23	77
Total	-	-	**156**

Contractor Interviews

In December 2013, the Cadmus team completed interviews with 18 participating contractors in Ameren's territory. From a list of 327 actively participating contractors, we generated a random sample of 45 to contact. Our probability of selecting a contractor was weighted by the volume of participation. (A copy of the contractor interview guide is provided in Appendix D.)

Site Visits and Metering

In total, the Cadmus team metered 83 HVAC systems that received tune-ups and 78 new, high-efficiency HVAC systems installed through the program. To calculate savings impacts, the Cadmus team verified measure installations, metered CAC and HP cooling energy consumption, verified contractor measurements, and verified reported data. Our metering study was in compliance with *International Performance Measurement and Verification Protocol,* Option A.

To verify the operating efficiency and the correct charge of a sampling of systems, we conducting field spot measurement tests of the same parameters measured by contractors. Specifically, we tested:

- Airflow;
- Condenser power;
- Refrigerant temperatures and pressures;

- Supply and return air temperatures and humidities; and
- Outside air temperature.

We also installed numerous sensors on HVAC systems for long-term metering. Collecting data at two- or four-minute intervals, the meters recorded the following:

- Condenser kWh
- Indoor fan amperage
- Outdoor temperature and humidity at the condenser inlet
- Condenser exhaust temperature
- Supply temperature and relative humidity
- Return temperature and relative humidity
- Remote temperature and humidity sensor at the thermostat

Five of the 78 new HVAC sites and two of the 83 tune-up sites did not yield useable data; so we excluded their results from our analysis. Unusable data resulted from the following reasons:

- Meters were damaged (crushed or water damage) (3)
- Could not retrieve meters (2)
- HVAC system malfunctioned (1)
- Installation error (1)

We also used meter data to evaluate ECM savings and programmable thermostat savings. We provide a detailed discussion of our analysis methodology in the Gross Impact Evaluation Results section.

Engineering Analysis

To estimate per-unit gross savings for each CoolSavers measure, the Cadmus team used engineering algorithms and assumptions and all of the Ameren-specific inputs that were available. These algorithms yielded estimates of the difference between the energy usage of the rebated product and usage of a similar product that met the minimum federal standard for efficiency. Table 8 provides a brief overview of the engineering methodology we used to estimate savings.

Table 8. Engineering Analysis Summary by Measure

Measure	Baseline (Cooling)	Baseline (Heating)	Type of Savings Calculation
Air Source HP—Early Replacement of Air Source HP*	7.2 SEER determined from Cadmus meter data (PY10)	6.3 HSPF estimated from SEER and database correlating HSPF to SEER	Metered cooling, engineering estimate of heating savings
Air Source HP—Early Replacement of Electric Furnace*	7.2 SEER determined from Cadmus meter data (PY10)	Electric furnace (HSPF =3.412)	Metered cooling, engineering estimate of heating savings
Air Source HP—Replace at failure of Air Source HP*	13 SEER –federal minimum	7.7 HSPF – federal minimum	Metered cooling, engineering estimate of heating savings
Air Source HP—Replace at failure of Electric Furnace*	13 SEER –federal minimum	Electric furnace (HSPF =3.412; COP = 1)	Metered cooling, engineering estimate of heating savings
Ground Source HP	7.2 SEER determined from Cadmus meter data (PY10)	Electric furnace (HSPF =3.412; COP = 1)	Metered cooling, engineering estimate of heating savings
CAC—Early Replacement*	7.2 SEER determined from Cadmus meter data (PY10)	N/A	Metered cooling
CAC—Replace on Burnout*	13 SEER –federal minimum	N/A	Metered cooling
HVAC Systems Receiving Condenser Cleaning**	Pre tune-up EER from contractor reported measurements	Apply % EER improvement to HSPF for HPs	Apply ΔEER to metered cooling consumption
HVAC Systems Receiving Refrigerant Charge Adjustment**	Pre tune-up EER from contractor reported measurements	Apply % EER improvement to HSPF for HPs	Apply ΔEER to metered cooling consumption
HVAC Systems Receiving Evaporator Cleaning**	PY10 evaluated results	PY10 evaluated results	
HVAC Systems Receiving General Maintenance	TRM deemed savings	N/A	Deemed
ECM Installed with AHRI Rated HVAC System	Already included in SEER rating	Already included in HSPF rating	Savings weighted using % of metered sites with continuous usage
ECM Installed (not in conjunction with HVAC system)	Engineering estimate	Engineering estimate	Engineering estimate
Thermostat Installed with Setback Programmed	TRM with weighted mix of HVAC systems and % of observed setbacks from meter data	TRM with weighted mix of HVAC systems and % of observed setbacks from meter data (from cooling only)	TRM values adjusted with observed metered temperatures and mix of HVAC systems

In general, we used metered data results and program tracking data to estimate cooling savings and engineering calculations to estimate heating savings. We present each algorithm and input assumption in the Gross Impact Evaluation Results section of this report.

Cost-Effective Analysis

Using final PY13 ConstructionSavers participation data, implementation data, and the *ex post* gross and net savings estimates presented in this report, Morgan Marketing Partners (MMP) determined the program's cost-effectiveness using DSMore.[4] MMP also calculated measure-specific cost-effectiveness. As shown in the Cost-Effectiveness Results section, we assessed cost-effectiveness using the five standard perspectives produced by DSMore:

- Total Resource Cost
- Utility Cost
- Societal Cost Test
- Participant Cost Test
- Ratepayer Impact Test

[4] A financial analysis tool designed to evaluate the costs, benefits, and risks of demand-side management programs and services.

PROCESS EVALUATION FINDINGS

This section contains the Cadmus team's process evaluation findings for Ameren's CoolSavers program. CoolSavers replaced the CheckMe! Plus program, which Ameren offered from PY09 through PY11. We have organized our findings into three sections: Program Design and Delivery, Marketing and Outreach, and Program Satisfaction.

Program Design and Delivery

According to stakeholders, CoolSavers was designed to achieve meet three main objectives:

- Broaden the market supply for high-efficiency HVAC equipment and diagnostic tune-up services;
- Educate customers about Ameren's full suite of residential energy-efficiency offerings; and
- Minimize NTG impacts.

Ameren acknowledged one significant difference between CheckMe! Plus and CoolSavers: under the previous program, real-time data were recorded before a rebate was issued. Thus, the CheckMe! program instantly assessed the quality of contractors' reported measurements by requiring them to call in their diagnostic test measurements.

HVAC Replacement

Table 9 shows a summary of incentives offered by the CoolSavers program for installation of AHRI-rated HVAC systems. Higher rebates are offered if the existing system is operating and replaced early through the program. In PY13, there were 6,738 CoolSavers replacement participants.

Table 9. Rebated HVAC System Measure Summary

Qualifying Products	Rebate Amount
CAC (SEER 14, 15, 16+)	up to $425
Air source HP (SEER 14,15, 16+)*	Up to $650
Electronically commutated blower motor (ECM)	up to $100
Geothermal HP*	up to $600
Programmable Thermostat	$20

*Replacing an electric HVAC system.

Other CoolSavers Measures

Table 10 shows additional measures offered through the CoolSavers Program. The vast majority of ECM installations were in conjunction with a new HVAC installation measure, and almost all programmable thermostats were installed with a new system.

Table 10. HVAC Tune-up

Measure	Rebate
CAC or air source HP tune-up	$75
Electronically commutated blower motor (ECM)	up to $100
Programmable Thermostat	$20

Communication and Program Processes

The Cadmus team found that stakeholders generally agreed on most issues. Stakeholders acknowledged initial startup issues occurred (as detailed below). However, with those issues now resolved, stakeholders believe that the program runs well at this time. Communication between ICF and Ameren—both formal and informal—is positive and frequent.

Overall, the program appears to be operating smoothly, and rebates are at expected levels. The most significant factor for both Ameren and ICF was the need for a dedicated, local program manager—a role that was ultimately filled in the early fall.

Contractor Technical Training

A little more than one-half of the contractors reported that the technicians had attended the technical training or planned to. Many who received training said they appreciated that the trainer was willing to come to them.

When contractors were asked if they learned anything new from the technical training, responses varied. A few offered examples of refrigerant charge diagnostics. Most spoke of the airflow measurement and capacity calculations. Examples include the following:

- "We never knew how to measure airflow correctly. Now we use a Testo [anemometer] and perform a traverse (three paths) and we also take static pressure to compare. We use the Optimizer tool in every tune-up, even those that don't improve capacity, to show customers our technical knowledge and level of service."
- "Now we know how to calculate capacity."
- "It was a good refresher, especially for some of my senior HVAC techs."
- "Didn't really learn anything new."

Program Process—Contractor Perspective

We discussed the technical process (tune-up process and commissioning process), and contractors did not raise issues with the work required (e.g., airflow measurements, checking refrigerant pressures). Several reported they found the form (optimizer) easy to understand for such a technical document.

Many (over 60%) contractors said they would prefer to reduce the amount of paperwork, but none offered suggestions for how to do this. Some contractors indicated they had no problems with the paperwork required.

A few administrative personnel indicated the online data submission forms could be improved. For example, the order in which data are entered could be changed to align with the way AHRI data are reported.

Other than three contractors citing examples of rebates that took too long to process, they expressed satisfaction with rebate processing times.

Many (a majority of) contractors simply reported: everything about the program made sense; they were happy with it; and they had no suggestions for changes.

Program Implementation Challenges and Solutions

In interviews with the Cadmus team, stakeholders identified several challenges in PY13 that negatively affected program participation and savings.

- Cooler weather than anticipated.[5]
- Poor quality of data (such as missing or erroneous tune-up diagnostic measurement information).
- More time than expected was needed to get the program operational (including designating a project manager).

Stakeholders also expressed concern about the aggressive goals for PY13—specifically, that tune-up goals might not be reached because of the reluctance of some contractors to participate, following their experience in the previous HVAC program. According to stakeholders, contractors continue to express concerns about the program's tune-up reporting requirements. The primary complaint from contractors is the requirement to write down and report diagnostic test measurements.

Despite these issues, the new program design resulted in attracting three times the number of contractor participants as the CheckMe! program. CoolSavers' design also has eliminated (or eased) some contractor concerns about data reporting and measure eligibility. Participation has increased over that in the previous CheckMe! program years; CoolSavers incented more tune-ups in eight months than occurred throughout the entire CheckMe! program.

Contractor responses varied when asked whether the rebates prompted early replacements or sales of high-efficiency units. Responses included:

- "We only sell high-efficiency units. We've seen an uptick in sales, but this could be weather related. I do feel the availability of the incentive makes the sale easier."
- "We've changed our whole marketing strategy to push tune-ups"

[5] Spring 2013 was cooler than average. Consequently, contractors could not perform some tests required by the program, resulting in lower-than-expected participation.

- "I would like to see an additional incentive offered for higher-efficiency units (e.g. 20+ SEER). The rebates don't correlate with the added cost of very high-efficiency units."
- Sixty-one percent of contractors reported using the tune-ups to sell maintenance agreements.

Delivery Successes and Program Achievements

When the Cadmus team asked which aspects of the program were working particularly well, stakeholders reported the following:

- Ameren and ICF have established productive relationships with distributors and contractors. Distributors have provided access to their facilities and, with help from their territory managers, have trained local contractors. Distributors also are providing AHRI certificate information, which makes the rebate application process easier for contractors.
- The CoolSavers program is meeting the needs of contractors for training and rebate processing, as ICF staff members have been sufficiently available. Currently, ICF has five, full-time Missouri-based employs to support the HVAC programs, and these employees work with participating contractors on a daily basis.

Marketing and Outreach

This section contains the Cadmus team's findings on CoolSavers marketing strategies and outcomes.

Marketing Goals and Primary Channels

The primary marketing channel for CoolSavers is mass marketing through: direct mail, gas toppers, digital media, billboards, radio promotions, television, and radio appearances, and other advertising. In a recent market segmentation study, Ameren identified a significant number of customers who are likely to participate in the CoolSavers program.

The program implementer indicated it accessed previously conducted segmentation data, provided by Ameren, and paired these with usage data to target customers with high usage rates and a high propensity for participation. This research was used to establish the direct-mail strategy, which launched in May and continued throughout the summer, as well as other integrated tactics (such as the e-mail blasts, free-standing inserts, and gas pumps). The consumer marketing did not officially launch until late spring, once the contractor base had been developed. A number of the activities, established in Ameren's marketing plan, began in earnest in June 2013.

Marketing Materials

The Cadmus team reviewed the PY13 CoolSavers' marketing materials, planning and strategy documents (such as marketing plans and recaps), and marketing metrics tracking reports. We reviewed the marketing materials such as the sample shown in Figure 1.

Figure 1.Marketing Material Samples

Overall, the pieces present a consistent look and feel, include a direct call-to-action, and closely follow the Act On Energy® brand guidelines in terms of fonts, colors, and layout. Each piece we reviewed featured the Ameren logo and a prominent CoolSavers logo, the toll-free number in boldface, the ActOnEnergy.com URL, and headlines describing program offerings (e.g., total rebate amounts). Most pieces featured an image of a family and messaging about year-round comfort in the home, which created a personal and relatable feel to the program and communicated the benefit of the program to potential participants.

Ameren offers a cooperative marketing program that provides contractors with up to $1,500 to support their marketing efforts, and ICF manages the co-op reimbursement process. Although ICF said that having the Ameren logo on materials is very important as it validates to customers the quality of the contractors' work, there has been relatively little contractor participation in the co-op program thus far.

ICF and Ameren jointly review and approve the marketing materials provided by contractors. ICF noted that reviewing these marketing materials often proves challenging, as the contractors tend to use the Ameren logo inconsistently. Seeking to maintain consistent messaging in the market, ICF is working to clean up old or inaccurate messages and to provide prompt, helpful feedback to contractors. The samples shown in Figure 2 show misuse of Ameren's logo and the misapplication of its brand guidelines.

Figure 2. Contractor Cooperative Advertising Samples

Summer 2013 Campaign

In addition to ICF's efforts, the corporate marketing and residential, energy-efficiency management teams at Ameren supported the promotion of the CoolSavers program in PY13. From June to August 2013, the corporate marketing team promoted the CoolSavers program (in addition to the ApplianceSavers program) through its Act On Energy marketing and media. The campaign included: radio spots, digital billboards, out-of-home billboards, transit windscreens, animated and static banner advertisements, social media, direct mailers, gas toppers, and e-mail marketing. Through the Act On Energy campaign, customer engagement was enhanced through the addition of the energy-efficiency look-up.

Based on the campaign recap, the CoolSavers program realized an uptick in applications during the early part of the campaign, experienced increased inbound call volumes, and found that 70% of installs occurred in the high-propensity ZIP codes targeted by direct mail. Also, the number of visitors to the CoolSavers website increased nearly fourfold over the previous time frame (29% of this increase was tied to paid web banners). Overall, Ameren stakeholders considered the summer campaign a success and felt it contributed to increased program participation during the summer months.

Cross-Program Promotion

Ameren identified and coordinated cross-promotional opportunities between the programs in its portfolio. The CoolSavers implementer works collaboratively with implementers of Ameren's RebateSavers and ApplianceSavers programs to target customers. For example, a direct-mail letter sent to CoolSavers participants referenced the rebates and appliance recycling program.

Act On Energy Campaign and Research

Ameren's corporate marketing and residential energy-efficiency management teams have further enabled and supported promotion of the CoolSavers program in PY13. In addition to the collaborative efforts involved in program-specific marketing planning, Ameren has focused its Act On Energy campaign efforts on developing innovative and integrated platforms to drive program participation.

Ameren also has conducted segmentation, potential, and usability studies to inform program design and outreach efforts. The segmentation study, conducted by The Shelton Group, researched Ameren customer propensity to participate, perceived participation barriers, and message and media considerations.

While Shelton did not conduct the study solely on a program-specific basis, the following findings prove relevant for the CoolSavers program (and Ameren customers overall):

- A high percentage of Ameren customers (62%) rate their home as being either somewhat efficient or very efficient, which is a much higher percentage than Americans overall (42%).
- Cost is the main barrier to making home energy-efficiency improvements (40%).
- Customers consider the following needs as most pressing: high-efficiency water heaters (32%); high-efficiency CAC (31%); and high-efficiency heating systems (31%).
- More than 80% of customers surveyed use a CAC system:
  - Of those with a CAC/HP, 18% will likely consider participating in the rebate program.
  - Of those with a window AC unit, 30% will likely consider participating in the rebate program.
  - Air conditioning replacements tend to be need-driven (43%).
  - 41% express reluctance to replace units and 29% cannot afford to make replacements.
- 28% percent of customers with a CAC/HP will likely to participate in a diagnostic tune-up.
- Customers consider Ameren the best source for the diagnostic tune-up program (73%), followed by their local service person (57%).

Additional Contractor Insight

Some contractors said a few customers asked about Ameren tune-ups. Other contractors reported customers were generally aware of the program. One contractor reported they were not prepared for the flood of calls they received from customers asking for an Ameren tune-up. The calls occurred before they fully came on board with the program, and they did not know what to tell customers. Many contractors noted they were impressed with the amount of marketing Ameren did for CoolSavers.

One contractor suggested Ameren might recommend a fixed price for an Ameren tune-up, but also admitted Ameren probably was not in the business of standardizing prices. The contractors point was: as Ameren is standardizing the tune-up process, the price of a CoolSaver tune-up should be the same. They lost money if a customer became confused about their “early bird” special ($79), which generally is not a full CoolSavers tune-up.

Program Satisfaction

The Cadmus team surveyed program participants who received a tune-up or who installed a new HVAC system. Our surveys asked program participants to rate satisfaction with the following three elements:

- Overall experience with the program;
- The service and quality of work provided by the program contractor; and
- The performance of the new or tuned-up HVAC system.

Overall, participants expressed satisfaction with all program aspects and with Ameren.

Overall Program Satisfaction

Most tune-up participants described themselves as *very satisfied* with the program overall (88%), while most remaining participants (11%) were *somewhat satisfied*. Most early replacement participants described themselves as *very satisfied* with the program overall (82%), while most remaining participants (17%) were *somewhat satisfied*.

Both tune-up and new HVAC installation participants were asked "what suggestions, if any, do you have for improving the program?"

Twenty percent of the new replacement HVAC participants suggested that Ameren should improve its marketing and outreach effort or should make a more concerted effort to provide energy-saving tips. The remainder of the participants either had no suggestions or recommended larger incentives.

Most tune-up rebate recipients did not offer any suggestions for program improvements. Of the 20 participants offering a suggestion, 13 (65%) respondents suggested some type of customer awareness improvement or explained they wanted Ameren to provide additional information about the service work performed or other energy-saving measures.

Satisfaction with the Participating Contractor

Nearly all participants (97%) who installed new HVAC systems described themselves as *very satisfied* with the contractor performing the installation.

The vast majority of participants (93%) who had their HVAC system tuned-up described themselves as *very satisfied* with the contractor performing the installation. Only one participant claimed they were *not too satisfied* with their contractor because according to this participant, the contractor attempted to sell a device or service that was not needed.

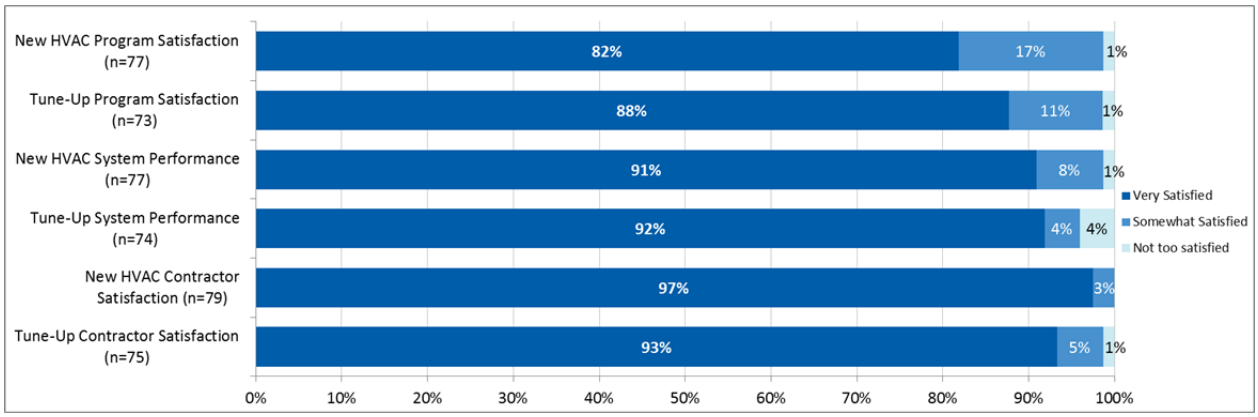
Satisfaction with the System/Measure Performance

Most tune-up participants described themselves as *very satisfied* with performance of their HVAC system receiving a tune-up (92%), while 4% of remaining participants *somewhat satisfied* and 4% were *not too satisfied*. The majority of those who claimed they were very satisfied explained that the system worked as they expected it to or worked even better than before. A few respondents mentioned they were impressed by the level of rigor required of the program.

Most early replacement participants described themselves as *very satisfied* with their new HVAC system (91%), while most remaining participants (8%) were *somewhat satisfied*. Most participants explained

they were happy with their new system because of the improved comfort level in the home or because they saw a decrease in their monthly utility bills.

Figure 3. Satisfaction with Program, HVAC System/Service, and HVAC Contractor for New and Tuned-UP HVAC Units



CSR Summary

According to the Missouri Code of State Regulations (CSR),[6] demand-side programs that are part of a utility's preferred resource plan are subject to ongoing process evaluations that address, at a minimum, the five questions listed in

Table 11. This table offers a summary response for each specified CSR requirements.

Table 11. Summary Responses to CSR Process Evaluation Requirements

CSR Requirement Number	CSR Requirement Description	Summary Response
1	What are the primary market imperfections common to the target market segment?	The primary market imperfection common to the target market is inadequate information and/or knowledge regarding the energy-saving benefits of proper HVAC maintenance and high-efficiency HVAC systems for cooling and electric heating. Additionally, the investment/cost of installing a new HVAC unit deters customers from ultimately making the decision to purchase until absolutely necessary. Further, when customers replace a system, the greater upfront cost of high-efficiency systems can cause them to purchase a lower-efficiency unit, even if the lifetime operating costs of the system are greater.
2	Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	Yes, the target market segment is appropriately defined and comprehensively serves for the single-family residential market. Specifically, the CoolSavers program is designed to help customers maintain the efficiency of operable systems (through tune-ups), and offers tiered incentives for customers replacing a failed and functional system (early retirement).
3	Does the mix of end-use measures included in the program appropriately reflect the diversity of end-use energy service needs and existing end-use technologies within the target market segment?	The program targets the primary end-use technologies within the targeted market segment. However, the program precludes incentives for installation of HP HVAC systems, which could decrease participation and limit energy savings potential.

[6] http://sos.mo.gov/adrules/csr/current/4csr/4c240-22.pdf

CSR Requirement Number	CSR Requirement Description	Summary Response
4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	Yes, current communication channels are appropriate as the program uses both mass media marketing to generate demand and interest in the program as well as targeted marketing through trained local HVAC contractors.
5	What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation of each end-use measure included in the program?	The current marketing materials allocate a significant proportion of resources specific to the targeted market. However, the most common suggestion for improvement from program participants surveyed was the need to increase program awareness and benefits, which indicates these efforts should continue.

GROSS IMPACT EVALUATION RESULTS

This section details how the Cadmus team calculated gross savings and determined realization rates for each measure's per-unit energy savings.

Site Visit Sampling

We performed field work in two waves, starting with participants who received incentives for installing a new HVAC system. Our second wave focused on tune-up participants.

We identified our metering sample of new HVAC system participants using a random selection of participants through April 5, 2013. After developing our sample frame, Ameren mailed letters explaining the study to 194 program participants. This mailer included our offer of a $150 Visa gift card for those willing to participate in the study. After recruiting 80 participants through this mailing, we began installing meters in mid-April, and we were done within a month.

As shown in Table 12, our metering sample of new HVAC system participants matched the program population exactly for two key characteristics: system size and average efficiency.

Table 12. Metering Sample and Program Population Comparison for New HVAC Metering Participants

	Average Installed SEER	Average Nominal Capacity
Metering Sample (n=78)	15.2	3.1
CoolSavers Population (n=6,738)	15.2	3.1

After completing installation of meters on 78 new HVAC systems,[7] the Cadmus team began recruiting HVAC tune-up participants. However, our metering of tuned-up systems was delayed because contractors could not begin tune-ups until the weather warmed.

Our metering of the tune-up participant sample occurred in two waves. First, we randomly selected 150 customers from a list of 350. (The list of 350 also omitted the practice units that contractors used when they became involved in the program.) We then worked with Ameren and ICF to avoid multiple interactions with customers who might have already received verification checks or follow-up contacts from ICF at the onset of the program. After sending 150 letters in early June, explaining the study to tune-up participants, we successfully recruited 54 metering participants for the first wave.

For the second wave, we randomly selected another 150 tune-up participants in late June from a list of 1,200. After Ameren sent letters to these participants, we recruited the remainder (26) of the tune-up metering participants to achieve our targeted total of 80.[8]

[7] Two participants rescheduled multiple times and ultimately did not participate in the study.

[8] In total, we installed meters at 83 tune-up sites because three participants called asking to participate in the study after we had recruited 80.

As shown in Table 13, the average size (in tons) of the metering study tune-up participant nearly matches the average size (in tons) of the population.

Table 13. Metering Sample and Program Population Comparison for Tune-Up Metering Participants

	Average Nominal Capacity
Metering Sample (n=83)	3.3
CoolSavers Population (n=2,800)*	3.2

*Not all reported tune-ups had tons reported,

On-Site Measure Installation Verification

Through participant phone surveys and site visits, the Cadmus team confirmed that the measures were installed and operating. Our verification activities for the tuned-up HVAC systems were different from our verification activities for the new systems.

New HVAC Installation Measures

Our verification of the new HVAC systems revealed a 100% installation rate. We verified proper installation by measuring airflows and refrigerant charges.

We measured sub-cooling values of all new HVAC systems and found four HVAC systems with sub-cooling values outside the range of the tolerated deviation from the target sub-cooling temperature.[9] Although the refrigerant charge deviated from the manufacturer's recommended level, we have no basis for adjustment/decrement of savings based on these observations.[10]

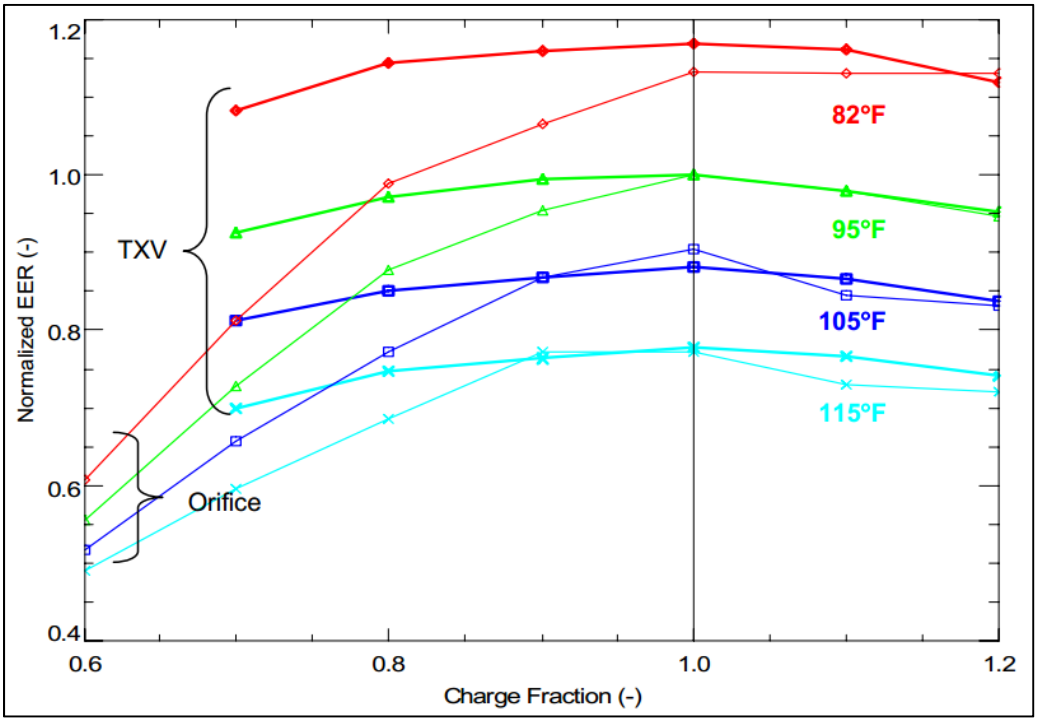
In general, thermal expansion valve (TxV)[11] systems effectively regulate refrigerant superheat and, therefore, are more tolerant of incorrect charges than are older systems. That is, having an incorrect refrigerant charge in TxV system has less of an adverse effect on expected system performance (Energy Efficiency Rating, EER) than in a system with a fixed orifice metering device. All four systems had TxVs. Figure 4 shows a relationship, by metering device at various outdoor temperatures, of refrigerant charge fraction (x-axis) to reduction in EER (y-axis).

[9] ACCA standard allows ±3°F of the OEM target sub-cooling value for TxV systems.

[10] Also note several home-owners mentioned the contractor planned to come back to commission the HVAC system because it was too cold to properly commission the system when it was installed.

[11] A TxV regulates the flow of refrigerant through the evaporator.

Figure 4. TXV and Fixed Orifice Correlation of Refrigerant Charge Deviation (by mass) to Reduction in EER*



*"Influence of the Expansion Device on the Performance of a Residential Split-System Air Conditioner," Report No. 491-01.4, PG&E, Technical Application Services, January 2001"

Figure 4 also shows how the addition or removal of refrigerant affects EER. As charge fraction changes from 0.7 (30% undercharged) to 1.0 (correctly charged) the change in EER of the TxV system is less than 10%. We might apply some % EER deviation to the systems we found that were not charged correctly, but doing so would require knowing the amount of refrigerant (by mass) necessary to correctly charge the system. We know that, for these systems, it is highly unlikely the nameplate efficiency used to estimate savings overstates by more than 10% given that, per to Figure 4, TxV systems operate within 10% of the expected EER over a wide range of the refrigerant charge amount.

In summary, we found that the manufacturer SEER value should reasonably represent the HVAC systems installed through the program. The metered results section explains how we used manufacturer information to calculate savings.

In addition to on-site verification of the HVAC system, the Cadmus team investigated the programmable thermostat installed through the program and recorded the program settings. We also verified the presence of an ECM fan and found 100% installation rates for both measures. (We discuss our findings for both programmable thermostats and ECMs in a subsequent section.)

Tuned-Up Systems

The Cadmus team verified that HVAC systems were tuned up (serviced in any way) by talking to home-owners, observing the cleanliness of the coils, and by verifying the refrigerant charge and airflow. To verify systems were tuned-up correctly, we recorded the following measurements:

- Airflow;
- Condenser power;
- Refrigerant temperatures and pressures;
- Supply and return air temperatures and humidities; and
- Outside ambient air temperature

We confirmed that three of 83 systems were incorrectly tuned-up. Specifically, they were overcharged with sub-cooling values greater than 15°F. Our further investigation of the data reported by the contractor for these three systems revealed that the data sets had issues; so we were unable to determine the initial condition of the HVAC system from the measurements reported. The adjustment we made based on this finding is discussed below.

- For the HVAC systems evaluated in the field, we reviewed all 83 data sets reported by ICF in detail. Approximately 30% of the reported measurements we investigated had some type of data issue. The main issues included the following:
  - At least one data point was not recorded (missing);
  - Pre and post values were identical;
  - Capacity or power recording was not reasonable or was erroneous; and
  - Outdoor temperature too low for testing. At the program onset, some units were considered "practice units" that the contractors used to familiarize themselves with the data collection requirements and field testing protocols of the program.

To estimate the improvement in EER from a tune-up, we used both the measurements from the 83 systems we verified in the field and the population of data reported by contractors. We expected some data quality issues early on, when the implementer and contractors were becoming familiar with the program's reporting requirements. After performing a detailed engineering review of all data, we removed approximately 30% of the reported tune-up measurements for the reasons listed above.

Table 14 shows the average pre- and post-EER values from the database of measurements reported by CoolSavers contractors. Note that ICF calculates EER from contractor measurements using its Optimizer tool,[12] and we independently calculated EER using the same measurements. Cadmus found the EER values differed from ICFs EER values by less than 1%.

[12] For example of data collected with Optimizer Tool see APPENDIX F. DETAILED ENGINEERING CALCULATIONS AND EXPLANATIONS.

Table 14. Pre- and Post-EER of Tune-Up HVAC Systems

Service Performed	Pre EER Average	Post EER Average	% Improvement	Count of Pre-Post Data Sets Used in Analysis
Refrigerant charge adjustment	8.72	10.64	22.0%	201
Condenser cleaning only	10.51	11.29	7.4%	1,861

We calculated energy savings using the efficiency improvement in Table 14 and the post tune-up metered energy consumption (discussed in measure-specific gross savings section). We made a slight adjustment for the three systems with an improper charge and no adjustment for the other 80 HVAC systems. Because savings and energy consumption are directly correlative, a system that uses more energy would effectively increase savings. Thus, if a contractor services a unit incorrectly, the unit will use more energy than if it was correctly tuned. For this reason, we investigated removing these three units from the sample. Ultimately, we chose to adjust the energy consumption using the data in Figure 4. We decreased the metered energy consumption of the two systems with TxVs by 10%, and we decreased the metered energy consumption of the system with fixed orifice metering device by 30%. These adjustments resulted in a savings decrease of less than 1% of the total measure savings.

We planned to use pre- and post-refrigerant diagnostic information to estimate the efficiency change with an alternative method: compressor mapping. We proposed to use the test-in and test-out refrigerant line pressures and temperatures to estimate refrigerant enthalpy and the mass flow rate using manufacturer compressor flow maps. This information would have allowed us to independently calculate refrigerant capacity and EER. Although ICF asked contractors to collect the information necessary to perform compressor mapping, the data recorded were insufficient. As a result, to estimate savings we had to rely on pre- and post-EER measurements calculated from evaporator capacity.

On-Site Metering

To evaluate key parameters, the Cadmus team used Option A of the IPMVP manual (Partially Measured Retrofit Isolation/Stipulated Measurement). Using this option as a guide, we performed the following measurement activities for the systems tuned up through CoolSavers and for new HVAC installs; these data allowed calculation of energy consumption, runtimes, and weather dependency:

- Spot-measured and logged the true power for sampled participants at a 2-minute intervals (this provided consumption, demand, and hours-of-use data in a single measurement).
- Using solar-shielded sensors, logged outdoor temperature in the vicinity of the condenser.
- Spot-measured the volts and amps and metered the amps of indoor fans at 2-minute intervals.
- Spot-measured airflow in cooling mode with a calibrated flow grid.
- Logged condenser exhaust temperature.

- Logged return air and supply air temperature and relative humidity at 2-minute intervals.
- Logged indoor temperature and relative humidity at 10-minute intervals at the thermostat.

To verify the loggers' accuracy, we performed spot power measurements for all logging input parameters. Table 15 lists the instruments we used to measure energy consumption, indoor conditions, and outdoor conditions. Approximately 15% of the installations used cellular-enabled meters, which enabled us to monitor the metered data and report results prior to meter removal.

Table 15. Metering Instrumentation

Function/ Data Point to Measure	Equipment Brand/ Model	Qty Req'd	Rated Full-Scale Accuracy	Accuracy of Expected Measurement	Planned Metering Interval
Energy/Time	Wattnode/WNB-3Y-240-P	1	± 0.05%	± 0.45%	2 min
Outdoor Ambient, Supply, Return Temperature/RH%	Hobo Microstation with S-TMB-M002 Sensor	1	±0.36°F/±3.5% RH	±0.3°F/±3.0% RH	2 min
Indoor Temperature/RH%	Hobo Temp/RH logger	1	±0.36°F/±3.5% RH	±0.3°F/±3.0% RH	10 min
Condenser exhaust temperature	Hobo S-TMB-M002 SS sensor	1	±0.36°F	±0.3°F	2 min
Fan Current	20 Amp CT	1	± 0.5%	± 0.5%	2 min

Figure 5 shows a Wattnode installed (circled) in the electric compartment of a condenser with the cover temporarily removed for installation.

Figure 5. True Power Meter Installed on Condenser

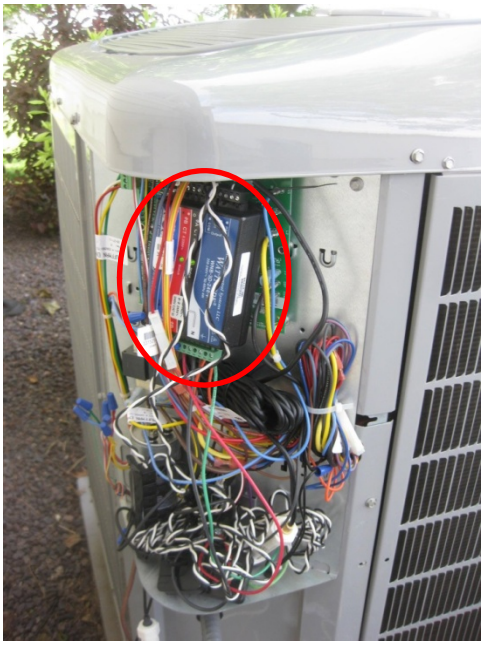
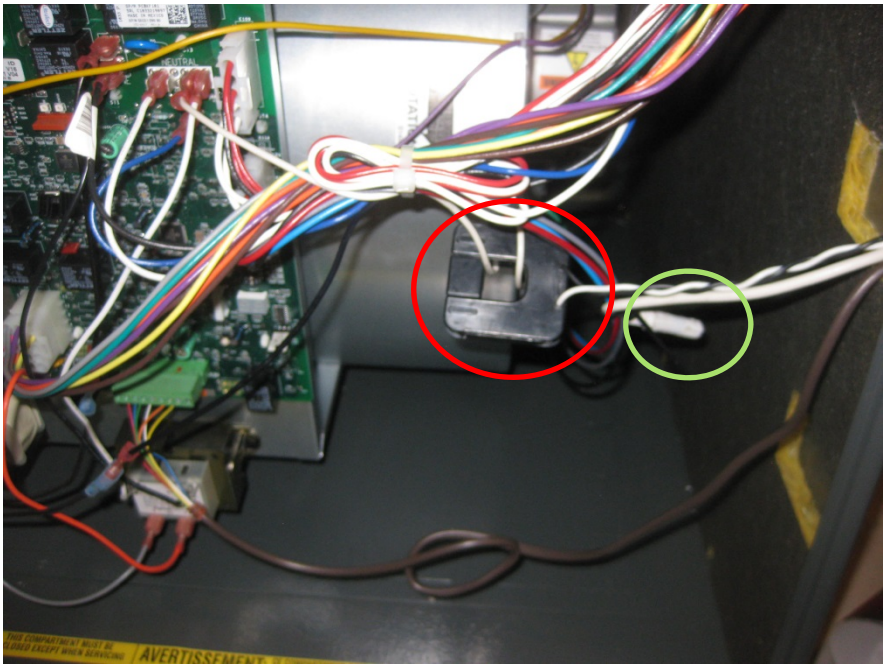


Figure 6 shows a current transformer (CT) installed on the wire feeding power to an ECM motor (circled in red), and the wire is double-wrapped around the 20Amp CT. The temp/relative humidity sensor is circled in green.

Figure 6. CT installed on ECM fan power and Temp/RH Return Air Sensor



Double-wrapping the CT effectively doubles the current sensed by the metering equipment, thus improving accuracy proportionally.

Figure 7 shows a completed installation. The white box circled in red is a cellular logger we used at 15% of all metered sites to perform quality control checks and to provide interim energy consumption and savings analysis.

Figure 7. Cellular Logger (Completed Installation)

In total, we analyzed meter data from 81 HVAC systems receiving tune-ups and 73 new, high-efficiency HVAC systems installed through the program.[13] Table 16 provides a summary of the meter data results.

Table 16. Summary of Metering Results

Measure Type	Population	Metered Sample Size	% of Season Metered*	Seasonal Metered Weather Normalized kWh	Coefficient of Variation (cv)	Relative Precision at 90% Confidence Interval
New HVAC System Installations	6,738	73	88.2%	1,892	0.56	10.9%
Tune-Up HVAC Systems	2,800	81	58.9%	2,836	0.57	10.6%

* The ratio of Base 65° CDD Metered/CDD 2013.

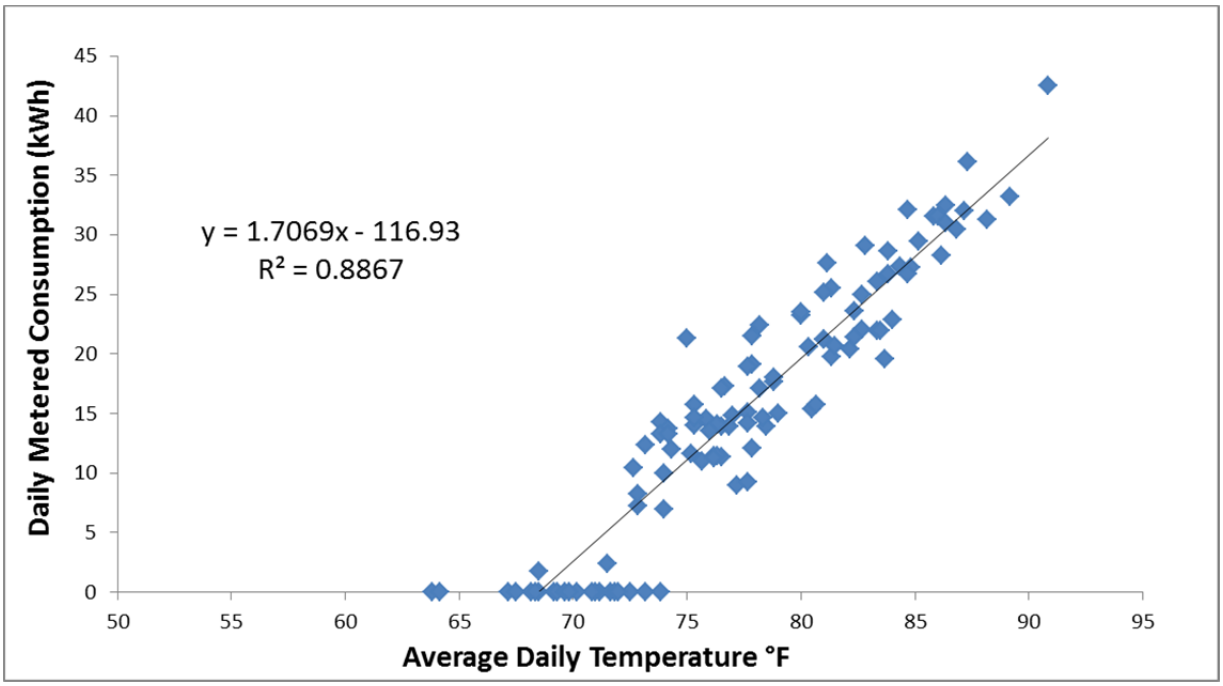
[13] We dropped two tune-up sites and five new HVAC sites from our analysis for the reasons previously discussed.

Weather Normalization and Extrapolation

New HVAC meters recorded data for nearly 90% of the 2013 cooling season, and the meters monitoring tune-up HVAC systems recorded data for nearly 60% of the cooling season. For the period not metered, the Cadmus team used Ameren's rank-and-average-weather-normalization technique. Ameren provided a daily average normal temperature and daily average temperature for each day in 2013 through October 31.

To calculate a regression, we plotted the daily total HVAC kWh metered energy consumption against daily average temperature. The slope of the regression line shows the relationship between kWh and temperature for each metered site. In the example shown in Figure 8, this example that slope is 1.71 kWh/degrees.

Figure 8. Metered Consumption Versus Average Daily Temperature (Example Site)



We multiplied the temperature difference between the actual daily average and the normal temperature for each day by the slope of the linear regression of each metered site. This resulted in a kWh adjustment (either positive or negative) for each day. We then subtracted the kWh adjustment from the metered data to estimate the "normal" metered energy consumption for each day. (We applied the same methodology to determine energy consumption for the period not metered.)

Because 2013 was slightly warmer than a 30-year normal summer, the ratio of the summation of actual metered data to normalized meter data shows that this year required an adjustment, which effectively decreased metered energy consumption by 3.9%.

Programmable Thermostat Metering Results

In addition to using meter data to estimate cooling savings, we used meter data to evaluate ECM savings and programmable thermostat savings. With our metered data, we calculated the percentage of CoolSavers participants who used their programmable thermostats in an energy-saving manner. Figure 9 shows a temperature/relative humidity logger sitting on top of a programmable thermostat.

Figure 9. Programmable Thermostat Temperature Logger

We assumed a home was saving energy if the average temperature increased at least two degrees above the occupied temperature setpoint. A higher indoor temperature decreases the heat gained by the home because the temperature differential between the conditioned space and the outside is minimized. In reviewing the data, we focused on the hourly average temperature for the months of July and August, and we looked at several hot weeks in other months.

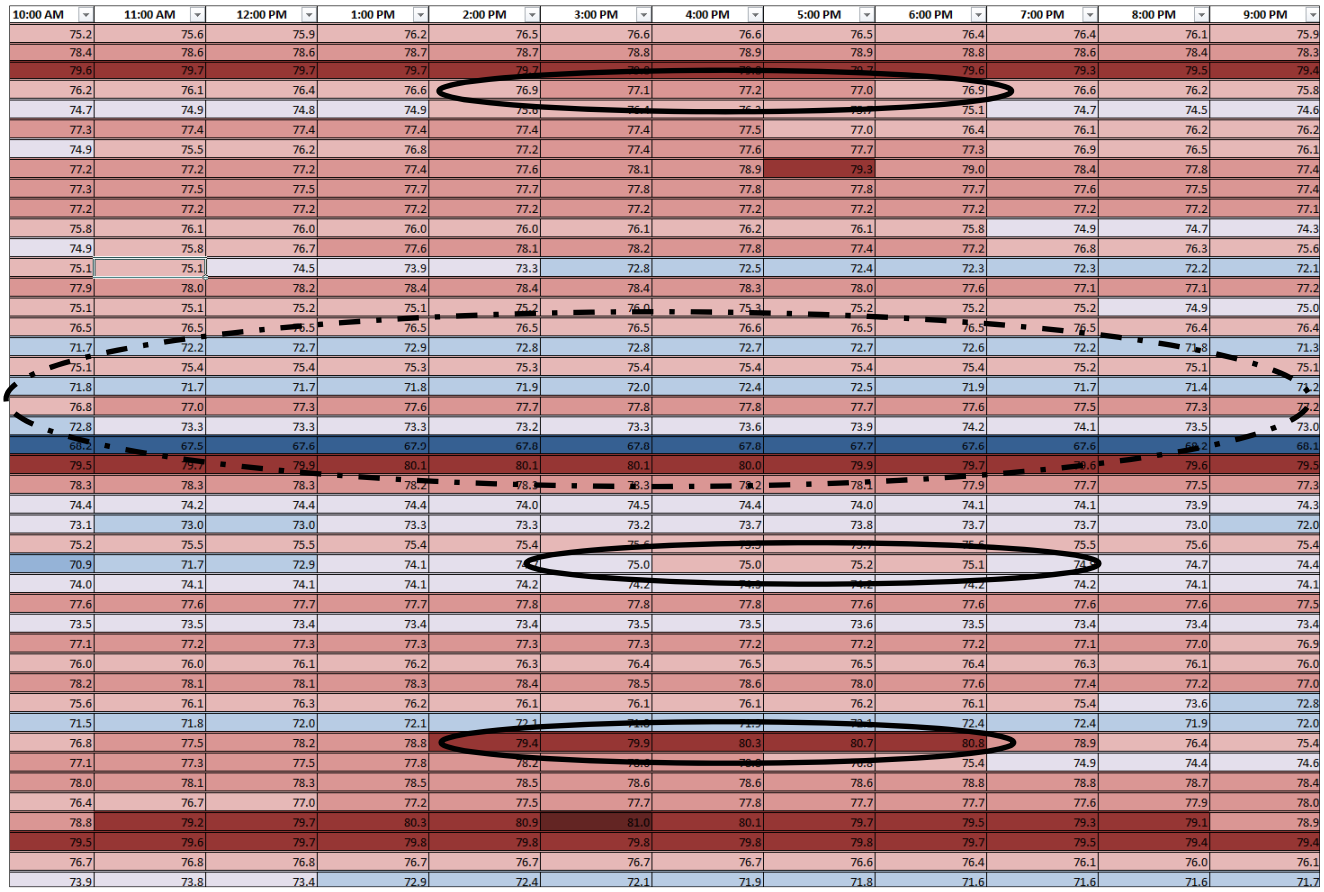
Figure 10 shows an example of a heat map[14] for some thermostats for the week of August 26, Monday through Friday. There is one column for each hour of the day, and each row shows the thermostat temperature for that hour for a metered participant. Our review of the months of July and August showed little or no setback or high uncertainty in the data because of variable user behavior and outdoor conditions.

We used visual temperature maps to investigate homes that were setting back the thermostat in a way that saved energy. Three time periods shown in Figure 10 illustrate some examples of average daily setback (solid black circled periods). In general, none of the setbacks were much higher than about 2°F for several hours. Many occupants kept their home at a constant temperature (see all participants circled by black dashed line in Figure 10).When we averaged the hourly temperatures for the week of

[14] Visual representation of temperatures we use to assess the temperature trends during various days, weeks, and months of the year.

August 26, we found that 17% of the homes in the CoolSavers study were setting back the thermostat in a way that saved energy – the home achieved a setback of at least 2°F.

Figure 10. Thermostat Heat Map



10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM
75.2	75.6	75.9	76.2	76.5	76.6	76.6	76.5	76.4	76.4	76.1	75.9
78.4	78.6	78.6	78.7	78.7	78.8	78.9	78.9	78.8	78.6	78.4	78.3
79.6	79.7	79.7	79.7	79.7	[illegible]	[illegible]	[illegible]	79.6	79.3	79.5	79.4
76.2	76.1	76.4	76.6	76.9	77.1	77.2	77.0	76.9	76.6	76.2	75.8
74.7	74.9	74.8	74.9	75.0	[illegible]	[illegible]	[illegible]	75.1	74.7	74.5	74.6
77.3	77.4	77.4	77.4	77.4	77.4	77.5	77.0	76.4	76.1	76.2	76.2
74.9	75.5	76.2	76.8	77.2	77.4	77.6	77.7	77.3	76.9	76.5	76.1
77.2	77.2	77.2	77.4	77.6	78.1	78.9	79.3	79.0	78.4	77.8	77.4
77.3	77.5	77.5	77.7	77.7	77.8	77.8	77.8	77.7	77.6	77.5	77.4
77.2	77.2	77.2	77.2	77.2	77.2	77.2	77.2	77.2	77.2	77.2	77.1
75.8	76.1	76.0	76.0	76.0	76.1	76.2	76.1	75.8	74.9	74.7	74.3
74.9	75.8	76.7	77.6	78.1	78.2	77.8	77.4	77.2	76.8	76.3	75.6
75.1	75.1	74.5	73.9	73.3	72.8	72.5	72.4	72.3	72.3	72.2	72.1
77.9	78.0	78.2	78.4	78.4	78.4	78.4	78.3	78.0	77.6	77.1	77.2
75.1	75.1	75.2	75.1	75.2	76.0	75.3	75.2	75.2	75.2	74.9	75.0
76.5	76.5	76.5	76.5	76.5	76.5	76.6	76.5	76.5	76.5	76.4	76.4
71.7	72.2	72.7	72.9	72.8	72.8	72.7	72.7	72.6	72.2	71.8	71.3
75.1	75.4	75.4	75.3	75.3	75.4	75.4	75.4	75.4	75.2	75.1	75.1
71.8	71.7	71.7	71.8	71.9	72.0	72.4	72.5	71.9	71.7	71.4	71.2
76.8	77.0	77.3	77.6	77.7	77.8	77.8	77.7	77.6	77.5	77.3	77.2
72.8	73.3	73.3	73.3	73.2	73.3	73.6	73.9	74.2	74.1	73.5	73.0
68.2	67.5	67.6	67.9	67.8	67.8	67.8	67.7	67.6	67.6	68.2	68.1
79.5	79.7	79.9	80.1	80.1	80.1	80.0	79.9	79.7	79.6	79.6	79.5
78.3	78.3	78.3	78.2	78.3	78.3	78.2	78.1	77.9	77.7	77.5	77.3
74.4	74.2	74.4	74.4	74.0	74.5	74.4	74.0	74.1	74.1	73.9	74.3
73.1	73.0	73.0	73.3	73.3	73.2	73.7	73.8	73.7	73.7	73.0	72.0
75.2	75.5	75.5	75.4	75.4	[illegible]	[illegible]	[illegible]	[illegible]	75.5	75.6	75.4
70.9	71.7	72.9	74.1	74.9	75.0	75.0	75.2	75.1	74.9	74.7	74.4
74.0	74.1	74.1	74.1	74.2	74.2	[illegible]	[illegible]	[illegible]	74.2	74.1	74.1
77.6	77.6	77.7	77.7	77.8	77.8	77.8	77.6	77.6	77.6	77.6	77.5
73.5	73.5	73.4	73.4	73.4	73.5	73.5	73.6	73.5	73.4	73.4	73.4
77.1	77.2	77.3	77.3	77.3	77.3	77.2	77.2	77.2	77.1	77.0	76.9
76.0	76.0	76.1	76.2	76.3	76.4	76.5	76.5	76.4	76.3	76.1	76.0
78.2	78.1	78.1	78.3	78.4	78.5	78.6	78.0	77.6	77.4	77.2	77.0
75.6	76.1	76.3	76.2	76.1	76.1	76.1	76.2	76.1	75.4	73.6	72.8
71.5	71.8	72.0	72.1	72.1	[illegible]	[illegible]	[illegible]	72.4	72.4	71.9	72.0
76.8	77.5	78.2	78.8	79.4	79.9	80.3	80.7	80.8	78.9	76.4	75.4
77.1	77.3	77.5	77.8	78.2	[illegible]	[illegible]	[illegible]	75.4	74.9	74.4	74.6
78.0	78.1	78.3	78.5	78.5	78.6	78.6	78.6	78.8	78.8	78.7	78.4
76.4	76.7	77.0	77.2	77.5	77.7	77.8	77.7	77.7	77.6	77.9	78.0
78.8	79.2	79.7	80.3	80.9	81.0	80.1	79.7	79.5	79.3	79.1	78.9
79.5	79.6	79.7	79.8	79.8	79.8	79.8	79.8	79.7	79.5	79.4	79.4
76.7	76.8	76.8	76.7	76.7	76.7	76.7	76.6	76.4	76.1	76.0	76.1
73.9	73.8	73.4	72.9	72.4	72.1	71.9	71.8	71.6	71.6	71.6	71.7

ECM Fan Metering Results

Approximately 60% of the new systems metered had ECM fans, while only about 20% of the tune-up systems had ECM fans. The rest of the fans were driven by standard (permanent split capacitor [PSC]) motors.

In reviewing the usage patterns of the standard (PSC) fan motors, we found that 8% of the metering participants ran the PSC fan continuously. Of participants with ECM fans, 15% ran their fans continuously. Research indicates ECM fans save significant energy compared to a PSC fan in circulation mode. No energy is saved when the fan is set to "auto" and only runs in cooling mode because the ECM savings are accounted for in the SEER rating of the HVAC system.

As we only analyzed data through October, we do not have sufficient data to understand the actual seasonal runtime in circulation mode. Currently, we are metering a sub-set of the ECM and PSC fans because we left 21 meters in place through the winter. Our savings analysis incorporates the assumption

that 8% of the population runs their fan continuously, while the rest of the population runs the fan sporadically or in auto-mode only.

Measure-Specific Gross Savings

Using the engineering algorithms outlined in the CoolSavers evaluation plan, the Cadmus team's engineers estimated measure-specific savings for all program measures. This section contains our estimates of gross energy savings determined for each measure and the algorithm and inputs we used.

SEER 14, 15, and 16+ CAC Installations

We calculated early-replacement savings for each metered interval (*i*) (either two or four minutes) using this algorithm:

$$kWh_i saved = metered\ kWh_i \times \frac{EER_{efficient}(T)}{EER_{base}(T)} - metered\ kWh_i$$

Using detailed manufacturer data (shown in Figure 11), we developed an EER versus outdoor temperature correlation for each new high-efficiency HVAC system we metered. We used a synthetic baseline curve (described in Appendix F) representing a 7.2 SEER HVAC unit. If the measure was defined as replace on burnout, we used the federal minimum efficiency rating of 13 SEER.

Figure 11. Example Manufacturer Cut Sheet

DETAILED COOLING CAPACITIES# (CONTINUED)

EVAPORATOR AIR		CONDENSER ENTERING AIR TEMPERATURES °F (°C)														
		75 (23.9)			85 (29.4)			95 (35)			105 (40.6)			115 (46.1)		
CFM	EWB °F (°C)	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**
		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡	
24ACB430A30 Outdoor Section With CAP**3014A* Indoor Section																
875	72 (22.2)	34.32	17.27	1.96	32.83	16.71	2.19	31.24	16.13	2.44	29.59	15.54	2.71	27.80	14.90	3.01
	67 (19.4)	31.45	21.21	1.96	30.06	20.64	2.18	28.59	20.05	2.43	27.04	19.44	2.71	25.38	18.78	3.01
	62 (16.7)	28.82	25.13	1.95	27.56	24.55	2.18	26.24	23.94	2.43	24.86	23.29	2.70	23.47	23.47	3.00
	57 (13.9)	28.00	28.00	1.95	26.98	26.98	2.18	25.89	25.89	2.43	24.74	24.74	2.70	23.48	23.48	3.00
1000	72 (22.2)	34.88	18.05	2.01	33.32	17.49	2.23	31.66	16.90	2.48	29.96	16.30	2.76	28.11	15.65	3.06
	67 (19.4)	31.98	22.49	2.01	30.53	21.91	2.23	29.00	21.31	2.48	27.40	20.68	2.75	25.69	20.03	3.05
	62 (16.7)	29.44	26.90	2.00	28.16	26.29	2.23	26.81	26.81	2.48	25.62	25.62	2.75	24.28	24.28	3.05
	57 (13.9)	29.10	29.10	2.00	28.01	28.01	2.23	26.85	26.85	2.48	25.62	25.62	2.75	24.28	24.28	3.05
1125	72 (22.2)	35.27	18.78	2.06	33.67	18.21	2.28	31.96	17.61	2.53	30.22	17.01	2.81	28.32	16.36	3.11
	67 (19.4)	32.36	23.68	2.05	30.87	23.10	2.28	29.29	22.50	2.53	27.66	21.88	2.80	25.91	21.21	3.10
	62 (16.7)	30.02	28.49	2.05	28.84	28.84	2.28	27.62	27.62	2.52	26.32	26.32	2.80	24.92	24.92	3.10
	57 (13.9)	29.99	29.99	2.05	28.84	28.84	2.28	27.62	27.62	2.52	26.32	26.32	2.80	24.92	24.92	3.10

Using this engineering algorithm, we determined the *ex post* savings values shown in Table 17. The savings we calculated are based on actual reported nameplate-rated efficiency (SEER) and unit capacity information (tons).

Table 17. *Ex Ante* and *Ex Post* Comparison for CACs

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	# Participants
CAC—SEER 14 ER	1,900	1,634	86.0%	1,965
CAC—SEER 14 Replace at Fail	409	346	84.7%	162
CAC—SEER 15 ER	2,057	1,960	95.3%	812
CAC—SEER 15 Replace at Fail	566	391	69.1%	55
CAC—SEER 16+ ER	2,202	1,913	86.9%	2,816
CAC—SEER 16+ Replace at Fail	710	382	53.7%	85

We metered 73 new HVAC units, averaging 3.1 tons and 15.1 SEER. We adjusted the savings metered (1,805 kWh) by a ratio of reported SEER and tons for each of the measure levels (SEER 14, SEER 15, SEER 16).

Our source for the *ex ante* savings estimate was the PY10 deemed savings value for early replacement measures, which assumes a mix of HPs and CACs. The *ex post* value is based on savings calculated from meter data of 73 new HVAC units installed in early 2013. *Ex post* savings for 16 SEER replace-on-burnout systems were actually less than the 15 SEER measure group because the average system size (tons) was smaller for the high-efficiency units.

The *ex ante* savings estimate for replace on burnout measures comes from Proctor Engineering Group. The assumptions cited are:

- 3-ton, single-family unit
- 1,215 full load hours

These assumptions do not yield the *ex ante* values when a standard savings calculation algorithm is used. For example, the *ex ante* savings estimate for a 14 SEER replace-on-failure unit is 409 kWh. The standard savings algorithm[15] is:

$$kWh\ saved\ = 1{,}215\ EFLH \times 12\frac{kBTU}{ton} \times 3tons \times \left(\frac{1}{13} - \frac{1}{14}\right) = 240\ kWh$$

The MML also provides an estimate for energy consumption of 13, 14, 15, and 16+ SEER CAC. The *ex ante* replace-on-burnout values are actually calculated by taking the difference between these consumption values, which are modeled estimates. However, we did not use the stated assumptions and algorithm. For the sake of comparison, we metered systems with an average SEER of 15.1. We found that, on average, these systems consumed 1,892 kWh in a typical cooling season. (MML assumes a 15 SEER unit consumes 3,412 kWh.)

The MML estimate of consumption is high compared to other TRMs and metered results of similar systems. To illustrate this, we benchmarked Ameren's *ex ante* and our PY13 *ex post* early replacement savings with those from various early replacement programs in Table 35. Although our *ex post* savings for early replacement measures are lower than Ameren's TRM estimates, they are higher than savings reported from similar programs. One reason for the difference is the assumed baseline; the baseline assumption of similar early replacement programs is typically 9 or 10 SEER—a conservative estimate is used because actual data are rarely available. We determined the actual operating efficiency of an early replacement system is 7.2 SEER by metering[16] existing units and then applying these data to nameplate

[15] This algorithm is found in the Energy Star calculator and in most TRMs.

[16] For the PY10 evaluation during Summer 2011, we performed long-term metering of the efficiency (EER) of 27 existing HVAC systems and developed a average EER versus temperature curve to estimate SEER.

efficiency values of replaced systems. Use of these values results in higher savings estimates. (See APPENDIX F. DETAILED ENGINEERING CALCULATIONS AND EXPLANATIONS).

Central HP Installations

The methodology the Cadmus team used to calculate CAC savings also was used to estimate cooling savings from the installation of high-efficiency HPs. This section describes only the heating portion of the savings calculation. (See the previous section for an explanation of the cooling savings calculation methodology).

All air source and ground source HP savings use the same general algorithm to estimate heating savings:

$$\Delta kWh = ratingofunit(tons) \times 12\frac{kBTU}{ton}\left[EFLH_{heating} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{efficient}}\right)\right]$$

Table 18 shows HP measures and baseline assumptions for HPs installed through the CoolSavers program. It also lists the participation total for each measure.

Table 18. *Ex Ante* and *Ex Post* Comparison for Air Source HPs

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	# Participants
ASHP—SEER 14 ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	81
ASHP—SEER 14 Replace at Fail with ASHP	13 SEER	7.7 HSPF		19
ASHP—SEER 14 ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		56
ASHP—SEER 14 Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		12
ASHP—SEER 15 ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	142
ASHP—SEER 15 Replace at Fail with ASHP	13 SEER	7.7 HSPF		19
ASHP—SEER 15 ER Elec Resist Furnace Early Replacement *	7.2 SEER	3.4 HSPF (COP=1)		144
ASHP—SEER 15 Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		14
ASHP—SEER 16+ ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	139
ASHP—SEER 16+ Replace at Fail with ASHP	13 SEER	7.7 HSPF		12
ASHP—SEER 16+ ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		111
ASHP—SEER 16+ Replace at Fail Elec	7.2 SEER	3.4 HSPF (COP=1)		10

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	# Participants
Resist Furnace*				

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	# Participants
GSHP—SEER 14+ ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		53
GSHP—SEER 14+ Replace Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		31

*Information about the cooling system is not known. The measure definition presumes the homeowner made the decision to switch from electric resistance heat and there is no cooling system criterion. We expect a cooling system was present and not recently installed.

Contractors did not report the HSPF nameplate values of air source HPs replaced early by the program; so we estimated HSPF values by correlating nameplate HSPF and nameplate SEER values of thousands of HP systems. The resulting HSPF for a 7.2 SEER baseline system is 6.3 HSPF.

To calculate heating savings, we used nameplate-rated HSPF and tons. We assumed the EPA estimate of 2,009 full-load heating hours[17] reasonably represents the energy consumption of a HP.

Table 19 shows the *ex ante* and *ex post* values for all HP measures reported in PY13.

Table 19.*Ex Ante* and *Ex Post* Comparison for HPs

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	# Participants
ASHP—SEER 14 ER with ASHP Early Replacement	4,201	4,530	107.8%	81
ASHP—SEER 14 Replace at Fail with ASHP	1,158	1,059	91.5%	19
ASHP—SEER 14 ER Elec Resist Furnace Early Replacement	14,917	12,905	86.5%	56
ASHP—SEER 14 Replace at Fail Elec Resist Furnace	13,426	12,173	90.7%	12
ASHP—SEER 15 ER with ASHP Early Replacement	4,683	5,106	109.0%	142
ASHP—SEER 15 Replace at Fail with ASHP	1,639	1,406	85.8%	19
ASHP—SEER 15 ER Elec Resist Furnace Early Replacement	15,398	14,255	92.6%	144
ASHP—SEER 15 Replace at Fail Elec Resist Furnace	13,907	12,951	93.1%	14
ASHP—SEER 16+ ER with ASHP Early Replacement	5,126	6,444	125.7%	139
ASHP—SEER 16+ Replace at Fail with ASHP	2,082	2,111	101.4%	12

[17] Energy Star Calculator - EPA DOE 2002 EFLH estimates

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	# Participants
ASHP—SEER 16+ ER Elec Resist Furnace Early Replacement	15,841	16,731	105.6%	111

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	# Participants
ASHP—SEER 16+ Replace at Fail Elec Resist Furnace	14,350	16,132	112.4%	10
GSHP—SEER 14+ ER Elec Resist Furnace Early Replacement*	15,841	28,485	179.8%	53
GSHP—SEER 14+ Replace Elec Resist Furnace*	14,350	27,207	189.6%	31

*The team relied on contractor reported data to estimate baseline efficiency and did not perform independent verification of the baseline assumption as the participation total was relatively low.

HPs represent 12.5% of the new HVAC installation measures, whereas CACs comprise 87.5% of the reported measures. Although the measure counts of HP installations are much lower, the total savings attributed to HP measures are much higher, with HPs representing 48% of the total new HVAC system installation savings.

Some of the new HVAC installations we metered were HPs, and we left several HP meters in place; so we could gain a better understanding of the full-load hour heating value. We will report the findings of this meter data in the PY14 report.

We calculated similar *ex ante* and *ex post* savings estimates for air source HPs. The overall realization rate of air source HPs was 101%, and the differences in savings could be attributed to:

- Metered cooling savings findings;
- Use of actual unit size (tons) and nameplate HSPF and SEER values; and
- Use of HSPF baseline value calculated from the early replacement SEER value.

The ground source HP *ex post* savings were much higher than the *ex ante* savings because we calculated the savings using the actual nameplate reported system size and efficiency. As of 4.5 tons was installed, with an average efficiency over 21 EER. (Note that the MML savings assume efficiency of 14 EER and 3 tons.)

Tune-Up Savings

As post-only verification and metering of tune-ups were performed, we relied on contractor efficiency improvement data to estimated savings. Our metered energy consumption of the tune-up sample was 2,836 kWh, normalized for TMY-3 weather.

To calculate tune-up savings, we used the following formula:

$$kWh\ Saved = \frac{kWh\ metered}{1 - \%\ EER\ improvement} - kWh\ metered$$

Table 20 shows the percent improvement in EER from contractors' reported measurements (for EER values see Table 14). An example of the field form used by contractors is included in APPENDIX F. DETAILED ENGINEERING CALCULATIONS AND EXPLANATIONS.

Table 20. Tune-Up Savings Summary

Measure	% Improvement	CAC Savings (kWh)	HP Savings (kWh)	*Ex Ante* (kWh)	*Ex Post* (kWh)	# Participants
Refrigerant charge adjustment	22.0%	605	1,421	191	687	502
Condenser Cleaning Only	7.4%	203	477	515	230	3,194
Maintenance and Tune-up	Deemed (TRM)	174	N/A	174	174	68
Indoor coil cleaning	From PY10: (51 kWh/ton)	161	379	638	183	256

The percentage of improvement in EER from contractor measurements occurred at various indoor and outdoor conditions. The Cadmus team found the pre- and post-EER values used in analysis[18] occurred at an overage outdoor temperature of 74°F.

EER varies with outdoor temperature, and the EER values for HVAC systems with different nameplate EER tend to converge as the temperature increases. For example, a 13-SEER unit might have EER of 11 at 95°F and a 16-SEER unit might have EER of only 12 at 95°F. Thus, if contractors performed pre- and post-EER testing at high temperatures, the efficiency improvement could be biased. However, we assume the change in efficiency from tune-ups at the average outdoor condition of 74°F represents the average change in efficiency for the entire season.

Table 20 also lists savings values for HVAC systems receiving refrigerant charge adjustments and for systems receiving condenser cleaning. We calculated average savings per measure from the metered energy consumption and adjusted this using the reported nameplate size (see Table 13).

Although ICF's Optimizer Tool includes a data collection field for heat system type (AC or HP), the program tracking database or tune-up measures did not discern HPs from CACs. We made the following assumptions to estimate savings for an average tune-up, which includes savings from HPs in heating mode:

- 10% of the system tune-ups were HPs (a conservative value based on the mix of known HP and CAC installations);
- The efficiency improvement is the same in heating and cooling mode; and
- Average HSPF after the tune-up was 6.3.

The MML values for refrigerant charge adjustment for indoor and outdoor coil cleaning cite Proctor Engineering Group (PEG) as the source for savings. These deemed savings values (638 kWh and 515 kWh, respectively) are based on a mix of various types of HVAC systems and building types. We reviewed the source for these numbers and found that PEG assumes the following:

[18] Some values were removed for various reasons described in the site visit verification section.

- Outdoor coil cleaning saves 7.5%.
- Indoor coil cleaning saves 4%.
- Refrigerant charge correction saves 10%.

The deemed savings for coil cleaning do not align with the original assumptions listed here. The MML values have inconsistent sources and are not correctly defined for single-family tune-up savings. The efficiency improvement from condenser coil cleaning found through our evaluation is 7.4%, which nearly matches the estimate from PEG (7.5%).

We did not update savings estimates for indoor coil cleaning. We could not use program tracking data to effectively estimate savings from this measure because participation was low and because systems receiving indoor coil cleaning often received other tune-up services. Instead, we used the per-ton savings estimate evaluated in PY10 (savings of 4%).

Unlike the other tune-up measures, the deemed savings for refrigerant charge adjustment cite MML modeling as the source for savings, not PEG. The *ex ante* value of 191 kWh is based on a 2.7 ton system and assumes the baseline system has 10% EER degradation from its nominal value. If a 10% EER improvement is realized through this measure, the deemed savings should be 10% of the consumption of an HVAC unit. As an example, MML lists consumption of an HVAC unit as 3,976 kWh; 10% EER degradation would result in 400 kWh savings, not 191 kWh. Clearly a disconnect exists between the refrigerant charge adjustment deemed savings and other HVAC assumptions and tune-up measures.

The efficiency improvement that the Cadmus team found through this evaluation (22%) is about two times higher than PEG's estimate of 10% EER improvement.[19] The majority of the systems receiving refrigerant charge adjustments also received condenser cleaning, which might explain why the evaluated savings were higher than reported. Furthermore, the refrigerant charge adjustment generally has the highest potential for energy savings improvement. Savings exceed 10% if the system is grossly over- or under-charged (see Figure 4).

The team compared the average savings from a CoolSavers tune-up to the savings from the previous program, CheckMe! Plus. The efficiency improvement and savings from condenser-cleaning measures was similar between the programs. The efficiency improvements and savings from systems receiving refrigerant charge adjustment were also similar. CheckMe! provided separate incentives for the various tune-up services, and, when only condenser cleaning was incentivized, many contractors chose not to participate in the program because of the time-consuming data reporting requirements. As a result, CheckMe! had higher average savings per tune-up because it serviced a higher proportion of systems requiring refrigerant charge adjustment. The CoolSavers program provides the same incentive for all

[19] For comparison, the MML refrigerant charge adjustment deemed savings of 192 kWh for refrigerant charge is 4% (based on adjustment from 2.7 to 3 tons and SEER 8 consumption).

tune-ups. Consequently, it had a lower proportion of systems needing refrigerant charge adjustment and thus lower savings per tune-up.[20]

A small number of tune-ups (n=68) reported did not receive any of the typical tune-up service measures (e.g., condenser cleaning or refrigerant charge adjustment). The MML measure claims a 10% improvement in EER from this generic measure, which would indicate energy savings are 10%; however, the deemed value of 174 kWh does not represent 10% energy savings. The Cadmus team accepted the TRM value for this measure because participation was low, making evaluation a low priority.

Programmable Thermostat Savings

Energy savings accrue when a home's temperature setting can be scheduled so less energy is used at specific times, thus reducing heat gain in summer and heat loss in winter. Programmable thermostats allow users to reduce energy consumption by raising cooling setpoints and decreasing heating setpoints during periods of their choosing, typically when occupants are away from the building or are sleeping. While the installation of programmable thermostats can lead to energy savings, user behavior is an important parameter to consider when determining energy savings.

Ameren TRM Savings Algorithm and Assumptions

The Ameren TRM provides a deemed savings value for what MML defined as moderate setback thermostats,[21] referencing the MML as the source of savings data.

Table 21. MML Programmable Thermostat Savings Estimates

System Type	Vintage	MML database kWh(1k sqft)	HVAC System Weighting	Vintage Weighting	Sq Ft Conversion[1]	kWh
CAC with gas furnace	Average	74	64%	88%	190%	79.1
	New	54	64%	2%	190%	1.4
	Old	95	64%	10%	190%	11.2
Central air source HP	Average	356	11%	90%	190%	68.9
	New	174	11%	4%	190%	1.7
	Old	570	11%	6%	190%	7.1
CAC with electric furnace	Average	657	24%	88%	190%	269.0
	New	417	24%	2%	190%	4.3
	Old	976	24%	10%	190%	44.0
Total						486.6

[20] The CoolSavers program design resulted in much higher participation than the CheckMe program. There is clearly a trade-off between the level of rigor and program participation. These topics are addressed in the conclusions and recommendations section.

[21] The Ameren TRM definition of moderate setback thermostat is: for the moderate case, the heating schedule was changed from 70 degrees F for all 24 hours of the day in the base to 65 degrees, from 11:00 pm to 6:00 am, using a setback thermostat. Cooling schedule was changed from 75 degrees F for all 24 hours of the day in the base to 78 degrees, from 11:00 pm to 6:00 am with the setback thermostat.

The savings value of for residential programmable thermostats provided in the TRM is based on the following factors:

- A weighted combination of home types;
- An assumed home size of 2,200 sq. ft.; and
- Savings representing a home with electric heating and CAC controlled by a new programmable thermostat that replaced a manual (unchanging) thermostat.

Thermostat Use Factor

We adjusted the program savings values in Table 21 by applying an efficiency factor for capturing any change in thermostat use that would result in energy savings.

To determine behavioral adjustments to the savings values calculated from the MML database, we analyzed metering data for the CoolSavers program. Our analysis revealed that 17% of the CoolSavers participants receiving programmable thermostats use these items in a way that saves energy (see Figure 10). We call this the "thermostat use factor," and we calculated energy savings for the program using the following equation:

$$Energy\ Savings\ \left(\frac{kWh}{Year}\right) = MML\ kWh\ X\ Thermostat\ use\ factor$$

We determined the thermostat use factor through review of summer meter data. For our analysis, we assumed the summer thermostat use factor also represents the use factor of winter setbacks. When additional winter meter data become available in PY14, we will update this assumption.

ECM Savings

We used a Wisconsin study[22] to estimate savings for ECMs installed through the Ameren CoolSavers program. ECM fans typically save energy in three ways:

- Cooling mode savings.
- Heating mode savings.
- Circulation mode savings.

The vast majority of ECMs (94%) were installed in conjunction with an HVAC system. An AHRI SEER rating of a cooling system often includes ECM savings in cooling mode. We randomly sampled 70 AHRI numbers of HVAC systems installed with an ECM and found the ECM was included in the AHRI rating in all cases. Consequently, the cooling savings are accounted for in the savings calculations for the new HVAC installation.

We reviewed some AHRI numbers reported for the ECMs that were not installed in conjunction with an HVAC system, and found these ECMs were typically installed as part of a gas furnace. Consequently, we

[22] *Electricity Use by New Furnaces, A Wisconsin Field Study*: Energy Center of Wisconsin. Page 41.

do not have information about the potential benefit to the cooling system, if a central cooling system exists.

The Cadmus team calculated savings in heating mode using the savings estimate from the Wisconsin study. We adjusted the savings by estimating the proportion of heating runtimes in Wisconsin to heating runtimes in Missouri. We assumed the HSPF rating of HPs included the benefit of the ECM fan, and we adjusted the heating savings by the percentage of HPs to CACs.

When we used our observation of meter data and fan runtimes to estimate ECM savings in the circulation mode, we found 8% of the metering participants ran the standard (PSC) fan continuously. Of participants with an ECM fan, 15% ran it fan continuously.[23] Our current savings analysis uses the assumption that 8% of the population runs their fan continuously, while the rest of the population runs the fan sporadically or in auto-mode only. Savings in continuous mode are high: 2,960 kWh. We assumed 8% of the ECM measures saved this amount of energy in continuous mode operation.

Our final estimate of ECM savings accounts for weather differences between Wisconsin and Missouri, and Table 22 contains our summary of ECM savings. Some contractors reported fan operations in continuous mode, but we learned these were not reliable data; so we calculated measure-level savings.

Table 22. ECM Savings Summary

Measure	*Ex Ante* (kWh)	*Ex Post* (kWh)	# Participants	Explanation
Concept 3 Installations Auto Fan Early Replacement	929	738	4,620	The fan replaced an existing fan
Concept 3 Installations Auto Fan Replace at Fail	929	738	234	The fan did not replace an existing, operating fan
Concept 3 Installations Continuous Fan Early Replacement	3,597	3,488	50	The fan replaced an existing fan that was on continuously

Ex ante values in Ameren's TRM are based on the following scenarios:

- Auto fan operation, when the fan operates only when the heating/cooling system is running.
- Continuous fan operation, the fan runs all the time.

[23] There is a possibility that some homeowners operate their ECM fans more frequently than they operated a standard fan motor, specifically because they know the ECM does not use as much energy. We do not, however, have qualitative or quantitative data showing the initial condition to support any adjustment to the baseline assumptions.

The energy consumption and demand estimates are grossly overstated. For example:

- The TRM assumes yearly energy consumption of a standard fan in a 13 SEER unit is 10,745 kWh in continuous mode. This is representative of a 1.5HP fan running continuously; however, most fans are 0.5 HP.
- The TRM assumes yearly ECM energy consumption is 7,148 kWh in continuous mode. On average, this means the ECM draws 816 watts, while, in reality, the draw is ~150 watts.

Although savings in auto-mode are overstated, *ex post* savings are about 80% of *ex ante* savings as meter data showed some continuous usage occurs. The Cadmus team left approximately 35 meters in place to record fan usage patterns for the entire year, which will provide data of the fan usage patterns in continuous mode through the shoulder seasons and winter.

Summary

Table 23 lists per-unit *ex ante* and *ex post* gross savings by measure.

Table 23. PY13 Summary: Comparison of *Ex Ante and Ex Post* Per-Unit Gross Savings

Measure	Per-Unit *Ex Ante* Savings (kWh/yr)	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate
Air Source HP—Early Replacement of Air Source HP*	4,745	5,491	115.7%
Air Source HP—Early Replacement of Electric Furnace*	15,469	14,896	96.3%
Air Source HP—Replace at failure of Air Source HP*	1,562	1,444	92.4%
Air Source HP—Replace at failure of Electric Furnace*	13,869	13,575	97.9%
Ground Source HP	15,291	28,014	183%
CAC—Early Replacement*	2,075	1,822	88%
CAC—Replace on Burnout*	522	364	70%
HVAC Systems Receiving Condenser Cleaning**	515	230	44.7%
HVAC Systems Receiving Refrigerant Charge Adjustment**	191	687	359.4%
HVAC Systems Receiving Evaporator Cleaning**	638	183	28.7%
HVAC Systems Receiving General Maintenance	174	174	100.0%
ECM Installed with AHRI Rated HVAC System	929	767	83%
ECM Installed (not in conjunction with HVAC system)	929	738	79%
Thermostat Installed with Setback Programmed	543	82.72	15%
Total			**86.4%**

*Combined incentive tiers (SEER 14, SEER 15, SEER 16).
**Savings adjusted assuming 10% of tune-ups were ASHPs which have additional savings in heating mode.

To estimate the program's total gross energy savings, we applied per-unit values in Table 24 to the CoolSavers' PY13 participation rates.

Table 24. PY13 Summary: Comparison of *Ex Ante and Ex Post* Per-Unit Gross Savings

Measure	PY13 Participation	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings (kWh/yr)
Air Source HP—Early Replacement of Air Source HP*	362	5,491	115.7%	1,987,723
Air Source HP—Early Replacement of Electric Furnace*	311	14,896	96.3%	4,632,629
Air Source HP—Replace at failure of Air Source HP*	50	1,444	92.4%	72,182
Air Source HP—Replace at failure of Electric Furnace*	36	13,575	97.9%	488,699
Ground Source HP	84	28,014	183%	2,353,150
CAC—Early Replacement*	5,593	1,822	88%	10,189,116
CAC—Replace on Burnout*	302	364	70%	109,975
HVAC Systems Receiving Condenser Cleaning**	3,194	230	44.7%	736,059
HVAC Systems Receiving Refrigerant Charge Adjustment**	502	687	359.4%	344,623
HVAC Systems Receiving Evaporator Cleaning**	256	183	28.7%	46,825
HVAC Systems Receiving General Maintenance	68	174	100.0%	11,825
ECM Installed with AHRI Rated HVAC System	4,670	767	83%	3,582,554
ECM Installed (not in conjunction with HVAC system)	234	738	79%	172,620
Thermostat Installed with Setback Programmed	4,473	82.72	15%	370,016
Total	**20,135**			**25,097,995**

*Combined incentive tiers (SEER 14, SEER 15, SEER 16).
**Savings adjusted assuming 10% of tune-ups were ASHPs which have additional savings in heating mode.

NET IMPACT EVALUATION RESULTS

The Cadmus team determined the NTG ratios using 156 participant surveys—79 that installed new high-efficiency CACS and 77 that had their existing system tuned up—completed in November 2013. We also used information from our interviews with 18 participating contractors, which we used in our free ridership scoring adjustments for all CoolSavers measures. In our experience, contractor interview data about a participant's intent is important because program participants often rely on their contractor's professional judgment and knowledge.

ECM fan measures are combined with new HVAC install measures more than 90% of the time; so we applied NTG results from the new HVAC installs to the ECM measure. We also applied NTG results from the new HVAC install measure surveys to the programmable thermostat measure as that equipment had to be installed in conjunction with a new CAC.

This section discusses the Cadmus team's methodology for calculating net savings by measure. Table 25 contains our estimates of the program's net impacts.

Table 25. PY13 CoolSavers NTG Summary

Program Measure	Percentage of Program Energy Savings*	Free Ridership	Participant Spillover	Nonparticipant Spillover (NPSO)	NTG Ratio
New HVAC Install and ECM	94.0%	22.7%	1.4%	19.2%	95.9%
Tune-Up	4.5%	36.6%			84.0%
Programmable Thermostats	1.5%	22.7%			97.6%
Overall			**1.4%**	**19.2%**	**95.4%**

*Based on Cadmus PY13 gross evaluated savings.

Free Ridership–New HVAC Installation Measure

The Cadmus team used the participant self-report approach to determine new HVAC installation free ridership. This approach relies on a standard battery of questions that define whether the participant:

- Had already purchased the product before learning about the incentive.
- Was planning to purchase the same product before learning about the incentive.
- Gave weight to the advice from the contractor to purchase the equipment.
- Would have purchased equipment that was just as energy-efficient without the incentive.
- Would have purchased the equipment at the same time as they did when they went through the CoolSavers program.

Based on participant responses, we applied a free ridership score ranging from 0% to 100% to each participant individually, based on their collective responses to the set of survey questions. Our process for determining an incentive-based measure, free ridership score is as follows:

- We categorized customers as 0% free riders in the following instances: (1) they had no plans to install the measure in the absence of the program's incentives, and would not have installed the measure within one year in absence of the program; (2) they had considered installing the measure before learning about the program, but would not have done so without program incentives; or (3) in the absence of the program incentives, they would have purchased or installed less-efficient equipment.
- We categorized customers as 100% free riders if they would have installed the same measure at the same time without the program.
- We assigned a partial free ridership score (ranging from 12.5% to 75%) to customers who already had plans to install the measure, but who said their decision about which product to purchase or when they would purchase it was influenced by the program. To customers who were highly likely to install the energy-efficient equipment right away and for whom the program had less influence over their decisions, we assigned a higher free ridership percentage than to those for whom the program may not have been as large an influence (or whose purchase may have occurred later in the program's absence).

After translating survey responses into each participant's free ridership score, we calculated an average free ridership estimate, weighted by evaluated savings, for the new HVAC installation subprogram. (In Appendix E, Table 40 shows: the conversion of each raw survey response option into free ridership scoring matrix values; and the free ridership score combinations and scoring legend we used to categorize customer survey responses for incentive-based measures.)

New HVAC Installation Free Ridership Results

The free ridership results for new HVAC installation are shown in Table 26.

Table 26. New HVAC Installation Free Ridership Results

Program Measure	FR Estimate	FR Absolute Precision
New HVAC Installation	22.7%	±5.4%

New HVAC Installation Measure Free Ridership Scoring

Appendix E, Table 43, contains: the full set of unique new HVAC installation measure, free ridership survey response combinations; the free ridership score assigned to each combination; and the number of responses. Responses of "yes," "no," or "partial" relate to whether the specific response indicates free ridership.

We found a common pattern appeared in the new HVAC installation respondents' answers to free ridership questions.

- Seventeen respondents indicated they would not have installed the measure to the same level of efficiency without the program incentive; and we estimated those 17 as 0% free riders.
- We designated seven additional respondents as 0% free riders because they would not have purchased the equipment within the same year without the Ameren rebate.
- We estimated five respondents as 100% free riders because they would have purchased equipment to the same level of efficiency and at the same time in the absence of the Ameren rebate.
- For respondents who confirmed they were going to replace their unit this year, but not necessarily with a high-efficiency system, we applied a free ridership decrement equivalent to the ratio of savings from a new installation from replace on burnout[24] to total savings of an early-replacement installation.

Other respondents' free ridership scores were less straightforward. We used partial score weighting, determined from contractor interviews, to estimate a free ridership score. Contractors reported they use the program incentive to sell higher-efficiency systems. The following statements generally describe the majority of contractors' thoughts about the program's influence:

- "We no longer sell 13 SEER systems because the early replacement incentives make a 14 SEER system about the same cost as a 13 SEER system."
- "We have always installed high-efficiency and promote it as an option to customers. Probably about half of the participants would have installed a 13 SEER."
- "Before the program, approximately 90% of our installations were 13 SEER. The incentive has significantly decreased our sale of 13 SEER units."

If respondents claimed the incentive had little or no impact on their decision to install a high-efficiency system but also claimed the contractor's influence was important, we applied a decrement to that respondent's free ridership score.

About 60% of participants claimed they planned to replace their unit this year, even without the program. During our interviews, contractors noted that customers are often "on the fence" about the decision to install a new system when the contractor arrives. The contractors said they believe that even though program participants might claim they were going to replace their system this year, in reality, they might: decide to wait and make only the minimal repairs necessary to keep the existing system operational; have their system tuned up; or do nothing.

We asked contractors specifically: "Of the participants receiving early-replacement incentives, what percentage do you believe made the decision to install a new unit this year because of the incentive?"

[24] Gross savings for replace-on-burnout are based on the assumption that a federal minimum efficiency (13 SEER) system would have been installed. Gross savings for early replacement measure are based on the efficiency of the existing HVAC system.

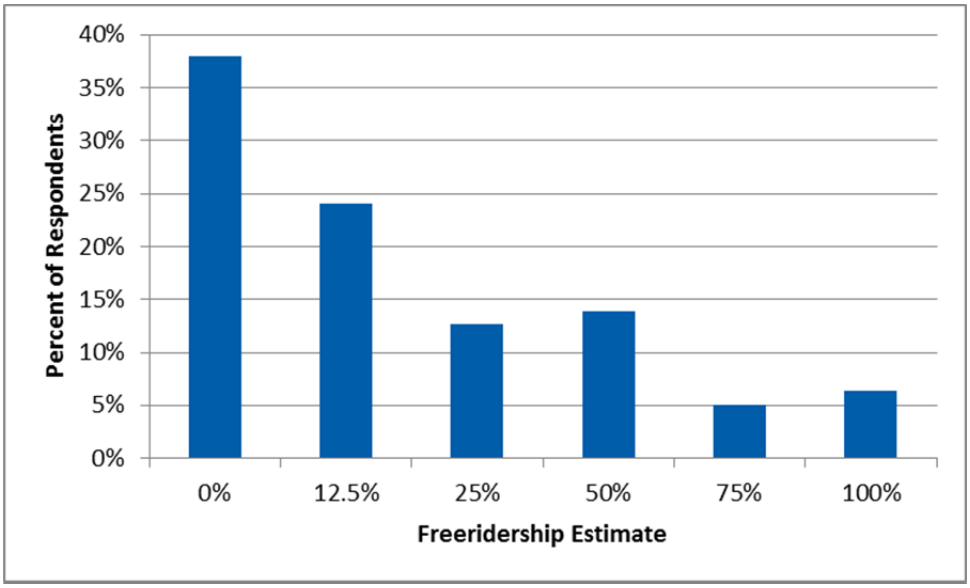
All contractors agreed that the timing of many customers' decisions to install a new unit definitely was influenced by the early replacement incentive.

When asked what percentage of their customers decided to replace this year, the contractors typically responded that about one-half to two-thirds replaced their systems this year due to the incentive when they otherwise would have deferred replacement. As these responses do not agree with the participants' self-reported responses (about 60% claimed they planned to replace this year, even without the incentive), we adjusted free ridership scores. If a participant claimed an intention to install this year, but also said their contractor had an important influence on the decision to install the new system, we applied a decrement to the free ridership score; so the results would more closely align.[25]

Distribution of New HVAC Installation Free Ridership Scores

Figure 12 shows the distribution of assigned free ridership scores. Approximately 38% of the new HVAC installation survey respondents were scored as 0% free riders, while 27% were estimated at low levels of free ridership (12.5% and 25%). Moderate levels of free ridership (50% and 75%) were estimated for 19% of respondents, while 6% of new HVAC installation respondents were estimated as true free riders (100%).

Figure 12. Overall Distribution of New HVAC Installation Free Ridership Scores



Free Ridership: Tune-Ups

The Cadmus team determined tune-up free ridership via a participant self-report approach, based on a standard battery of questions that defined whether the participant:

[25] From the 60% of the participants claiming they would have replaced units this year, those who noted the importance of contractors' influence received this decrement.

- Would have purchased a tune-up that was just as energy-efficient without the incentive
- Would not have purchased the CoolSavers tune-up with the $75 discount.
- Would have purchased a tune-up at the same time as they did when they went through the CoolSavers program.

We then applied a free ridership score, ranging from 0% to 100%, to all participants individually, based on their collective responses to the set of survey questions. Our process for determining an incentive-based measure, free ridership score is as follows:

- We categorized customers as 0% free riders in the following instances: (1) they had no plans to purchase the tune-up in the absence of the program's incentives, and would not have had the tune-up performed within one year in absence of the program; (2) in absence of program incentives, they would have had a less-efficient tune-up performed; or (3) they would not have had the CoolSavers tune-up performed within the same year without the discount.
- We categorized customers as 100% free riders if we determined there were no differences between the CoolSavers tune-up and their standard tune-up, and if they would have purchased the same CoolSavers tune-up without the discount sooner or at the exact same time. This was only possible for customers receiving the "condenser cleaning only" measure.
- We assigned a partial free ridership score (ranging from 12.5% to 75%) to customers who said they already had plans to have a tune-up performed. but that the quality of the tune-up was influenced by the program. For customers who were highly likely to have a comparable tune-up performed right away and for whom the program discount had less influence over their decision, we assigned a higher free ridership percentage than those whom the program may not have influenced as greatly (or whose tune-up purchases may have occurred later, in the absence of the discount).

We made scoring adjustments for anyone with a refrigerant charge adjustment or airflow adjustment. A 50% multiplier was applied to the participants' free ridership score if they had a refrigerant charge adjustment or airflow adjustment. Although we do not have a quantitative basis for this adjustment, we believe it is reasonable due to statements, such as the following, made by interviewed contractors:

- "We weren't ever checking airflow for tune-up service calls. Now that this is a requirement of the program we check airflow every time and have realized there were issues with units we would not have discovered before."
- "Before the tune-up program we generally did check refrigerant charge (by sub-cooling or superheat) but admittedly we might not have always done this, especially if we're busy and the system appears to be operating correctly."
- "We have not changed our condenser cleaning methods because of the program."

Based on statements like these offered by most of the contractors we interviewed, we assume a program tune-up that requires airflow adjustment and/or refrigerant charge adjustment saves 50%

more energy than a non-program tune-up. We made no adjustments if a participant had condenser cleaning only and no other service work performed, because no basis for a difference in savings exists from this service work with and without the tune-up program.

After translating survey responses into each participant's free ridership score, we calculated a weighted-by-evaluated savings, average, free ridership estimate for the tune-up subprogram.

Appendix F shows the conversion of each raw survey response option into free ridership scoring matrix values, and shows the free ridership score combinations and scoring legend we used to categorize tune-up customer survey responses.

Tune-Up Free Ridership Results

Table 27 shows the Cadmus team's free ridership results for tune-up respondents.

Table 27.CoolSavers Tune-Up Free Ridership Results

Program Measure	Free Ridership Estimate	Free Ridership Absolute Precision
Tune-up	36.6%	±7.3%

Tune-Up Measure Free Ridership Scoring

APPENDIX E. FREE RIDERSHIP SCORING FLOW CHART contains: the full set of unique, tune-up, free ridership survey response combinations; the free ridership score assigned to each combination; and the number of responses. Responses of "yes," "no," or "partial" relate to whether the specific response indicate
free ridership.

A common pattern appeared in the tune-up respondents' answers to free ridership questions:

- Twenty-seven respondents indicated they would not have had the CoolSavers tune-up within the same year without the Ameren discount; so we estimated those 27 as 0% free riders.
- We estimated 17 respondents as 100% free riders because no difference was explained by the contractor to the respondent about how the CoolSavers tune-up differed from a standard tune-up. They would have purchased the CoolSavers tune-up without the Ameren discount and at the same time in absence of the Ameren discount.
- We estimated at 50% free ridership another six respondents who gave the same answers, given they had a refrigerant charge adjustment or airflow adjustment (so we applied a 50% multiplier to their initial free ridership score).

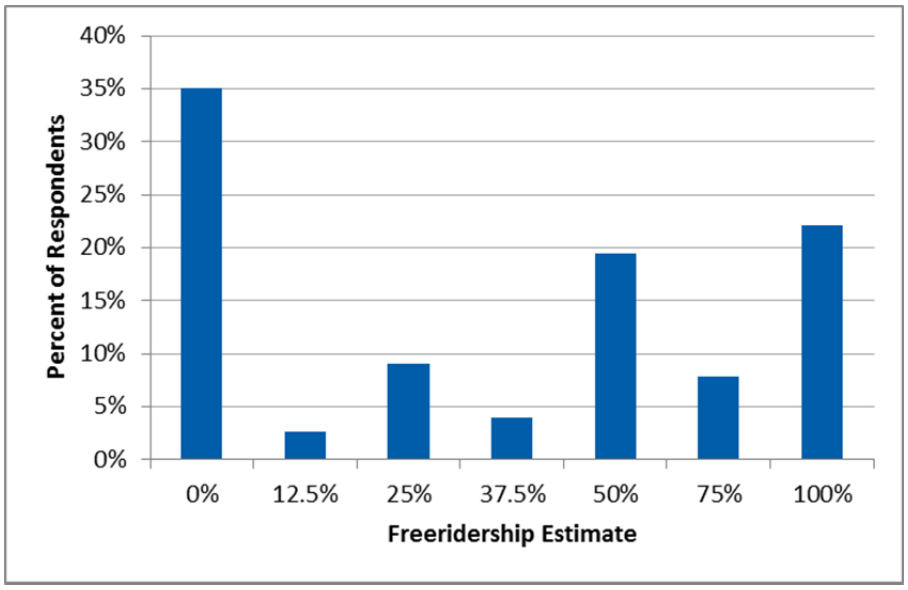
When we looked at the free ridership scores of customers with existing maintenance contracts and customers without maintenance contracts, we found the savings-weighted free ridership score for customers on maintenance contracts was 47%. Customers who did not have a maintenance contract had a free ridership score of 31%. Because it is easiest for contractors to recruit customers on

maintenance contracts, we expect the NTG ratio of the tune-up measure to increase as the program matures and contractors work to recruit new tune-up customers.[26]

Distribution of Tune-Up Free Ridership Scores

Figure 13 shows the distribution of assigned free ridership scores. Approximately 35% of the tune-up survey respondents scored as 0% free riders, while 16% scored at low levels of free ridership (12.5%, 25%, and 37.5%). Moderate free ridership levels (50% and 75%) were estimated for 27% of respondents, while 22% of tune-up respondents estimated as true free riders (100%).

Figure 13. Overall Distribution of Tune-Up Free Ridership Scores



Participant Spillover

The Cadmus team asked CoolSavers participants whether they had undertaken additional energy-efficient actions since participating in the program. To calculate spillover, we then asked them to rate the importance of receiving funding through Ameren's CoolSavers program in their decision to purchase the subsequent energy-efficient equipment. We considered measures to be attributable to program spillover only where the respondent answered "important" to the question. We also eliminated responses motivated by another Ameren program incentive to avoid the double-counting savings already captured by a concurrent program.

One survey respondent reported installing additional energy-efficient measures for which his or her participation in the CoolSavers program was "important" to the purchasing decision. The respondent

[26] Of tune-up participants, 54% had existing maintenance contracts, 44% were not on maintenance contracts, and 2% did not know.

installed high-efficiency insulation after participating in the CoolSavers program and did not receive funding for the insulation.

No surveyed tune-up participants attributed spillover measures to their experience or to participating in the Ameren CoolSavers program.

We estimated energy savings for the new HVAC installation participant's insulation spillover response. Next, we divided the total CoolSavers sample spillover savings by the total CoolSavers gross savings, drawn from the survey sample as described in the following equation:

$$\text{Spillover \%} = \frac{\sum[\text{Net spillover measure kWh savings for all survey respondents}]}{\sum[\text{Gross program measure kWh for all survey respondents}]}$$

This yielded a CoolSavers spillover estimate of 1.4%. Spillover details are presented in Table 28.

Table 28. New HVAC Installation Participant Spillover

Spillover Measure	Participant Spillover kWh/year Savings*	Total Survey Sample Program kWh/year Savings	Spillover
Insulation	3,168	225,489	1.4%
Overall	**3,168**	**225,489**	**1.4%**

*Savings based on engineering reviews of spillover measures.

Nonparticipant Spillover

Effective program marketing and outreach generates program participation *and* increases general energy-efficiency awareness among customers. The cumulative effect of sustained utility program marketing (which often occurs concurrently for multiple programs) can affect customers' perceptions of their energy usage and, in some cases, motivates customers to take efficiency actions outside of the utility's program. This phenomenon—called nonparticipant spillover (NPSO)—results in energy savings caused by but not rebated through a utility's demand-side management activity.

During PY13, Ameren Missouri spent over $1.6 million dollars to market individual residential efficiency programs and the portfolio-wide Act on Energy campaign. To understand whether Ameren's program-specific and general Act On Energy marketing efforts generated energy-efficiency improvements outside of Ameren's incentive programs, the Cadmus team implemented a general population survey of residential customers. We will repeat the survey for both PY14 and PY15 as we continue monitoring nonparticipant activity and tracking potential long-term changes in energy-efficiency awareness among Ameren's residential customers.

Methodology

Using Ameren's entire residential customer information system as the sample frame, the Cadmus team randomly selected and surveyed 401 customers. We determined that our sample contained a small number of customers (n=36) who self-reported that they participated in an Ameren residential program

in 2013. When estimating NPSO, we excluded these customers from our analysis, focusing on the 365 identified nonparticipants to avoid the potential double-counting of program-specific spillover.

We limited our NPSO analysis to the same efficiency measures rebated through Ameren programs (known as "like" spillover), with the notable exception of lighting products. Even though lighting is a "like" spillover measure, the NPSO analysis excluded it to avoid double-counting NPSO lighting savings already captured through the upstream LightSavers program market affects analysis.

To confirm a relationship between Ameren's energy-efficiency programs and the Act On Energy awareness campaign and actions taken by nonparticipants, the Cadmus team's survey asked about nonparticipants' familiarity with Ameren's energy-efficiency programs and Act On Energy. To be included in the NPSO analysis, nonparticipating respondents had to indicate: a) they were familiar with Ameren's campaign; and b) Ameren's efficiency messaging motivated their purchasing decisions.

Results

Of 365 nonparticipants surveyed, 11 cited Ameren's marketing as either "very important" or "somewhat important" in their decisions to purchase non-rebated, high-efficiency measures during 2013:

- Among nonparticipants citing their knowledge of Ameren's energy-efficiency programs or the Act On Energy campaign as "very important," we counted *ex post,* gross, per-unit savings, determined through the PY13 evaluation towards the NPSO analysis.
- If nonparticipants said Ameren was "somewhat important" in their decisions, we applied a 50% decrement and applied one-half of the *ex post* energy savings for the specified measure.

The analysis excluded the responses of nonparticipants who said that Ameren's programs or Act On Energy were "not very important" or "not at all important" to their efficiency actions.

Table 29 shows measures and gross evaluated kWh savings attributed to Ameren, with average savings per spillover measure of 242 kWh.

Table 29. NPSO Response Summary

Individual Reported Spillover Measures	Influence of Ameren Information on Purchase	Measure Savings (kWh)*	Allocated Savings	Total kWh Savings	Avg kWh Per Spillover Measure
Water Heater	Very	245.7†	100%	245.7	
Central Air Conditioner (CAC)	Somewhat	288*	50%	144.0	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	A
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Removed Refrigerator	Very	1,013ˆ	100%	1,013	
Scheduled CAC Tune-Up	Somewhat	993**	50%	496.5	
Water Heat Pipe Wrap	Very	363.8†	100	363.8	
Windows	Somewhat	271***	50%	136	
Total (n=11)				**2,662**	**242**

†Based on savings calculated for the RebateSavers program.

*Assumption used for the CoolSavers program's gross evaluated savings, based on a 2.5-ton unit rated at 15 SEER, with a baseline of 13 SEER.

ˆBased on savings calculated for the ApplianceSavers program.

**Assumption used for the CoolSavers program's gross evaluated savings, based on a 3-ton unit and a 7.7% efficiency improvement in heating and cooling for condenser cleaning.

***Based on savings calculated for the PerformanceSavers program.

To arrive at a single savings estimate (Variable A in Table 30), the Cadmus team used the numbers in the Total kWh Savings column to calculate an average for the 11 measures assessed for nonparticipant spillover. Thus, the estimate of 242 kWh represents the average nonparticipant energy savings per respondent who attributed spillover to Ameren's residential programs.

To determine the total NPSO generated by Ameren marketing in 2013, we used the following variables (as shown in Table 30):

- **A** is the average kWh savings per NPSO response.
- **B** is the number of NPSO measures attributed to the program.
- **C** is the number of nonparticipants contacted by the survey implementer.
- **D** is Ameren's total residential customer population.
- **E** is NPSO energy savings extrapolated to the customer population, calculated by dividing B by C and then multiplying this result by A and D.

- **F** is the total evaluated savings for the 2013 program year, for ApplianceSavers, CoolSavers, LightSavers, PerformanceSavers, and RebateSavers. (The analysis did not include CommunitySavers and ConstructionSavers.)[27]
- **G,** representing NPSO as a percentage of total evaluated savings, is the nonparticipant percentage used in the NTG calculations.

We estimated overall NPSO at 2.8% for the portfolio level, with a precision of 2.3%, as shown in Table 30.

Table 30. NPSO Analysis

Variable	Metric	Value	Source
A	Average kWh Savings per Spillover Measure	242	Survey Data/Impact Evaluation
B	Number of Like Spillover Nonparticipant Measures	11	Survey data
C	Number Contacted	365	Survey disposition
D	Total Residential Population	1,040,928	Customer database
E	Non-Part SO MWh Savings Applied to Population	7,592	(((B÷C)×A) × D)/1000
F	Total Evaluated Savings (MWh)	267,918	2013 Program Evaluations
G	NPSO as Percent of Total Evaluated Savings	2.8%	E ÷ F

In some jurisdictions, evaluators apply NPSO as an adjustment at the portfolio-level. Though a reasonable approach, it inherently assumes all programs contributed equally to generating the observed NPSO. This likely results in an inaccurate assumption, given the significant differences between the programs' marketing tactics and budgets as well as the programs' designs and scales.

Consequently, Ameren asked the Cadmus team to allocate the total observed NPSO to the individual programs that generated it. In doing so, the study considered each program's marketing expenditure in the context of a program's total net savings during the cost-effectiveness analysis.

The Cadmus team considered the following three approaches for allocating total observed NPSO to individual programs:

1. **Even Allocation**: The most straightforward approach allocates NPSO evenly across the residential programs (i.e., makes a 2.8% adjustment to each program's NTG). Doing so, however, is equivalent to applying NPSO at the portfolio-level, and therefore, as noted, assumes all programs contribute equally to generating NPSO.
2. **"Like" Programs:** Another approach allocates NSPO savings to specific programs, based on the measure installed by the nonparticipant or by the action they took. For example, one nonparticipant reported tuning up their CAC, based on energy-efficiency messaging from

[27] The Cadmus team excluded CommunitySavers and ConstructionSavers as both programs exclusively employ very targeted marketing; so marketing for these programs would likely generate little NPSO. For CommunitySavers, the program works directly with property managers of low-income buildings. For ConstructionSavers, most program marketing targets regional builders.

Ameren. Using this approach, we would assign NPSO savings associated with the tune-up to CoolSavers. While this approach establishes a clear connection between a reported NPSO measure and Ameren's program that promotes that measure, our research found this direct measure-program relationship did not prove as straightforward as it appeared. Specifically, while our study found all 11 respondents reporting NPSO were familiar with Act on Energy or Ameren's energy-efficiency messaging, only nine could cite specific program names. Further, just over one-half of the customers (6 of 11) who reported NPSO measures were unfamiliar with the program or the programs corresponding to the measure they installed. These findings indicated that Ameren generated NPSO through the cumulative effects of various program-specific and portfolio-level marketing efforts, and mapping NPSO measures solely to the program offering that measure could undervalue the overall impact of cumulative and sustained energy-efficiency messaging.

3. **Marketing Budget and Program Size.** The final allocation approach we considered—and eventually chose to use—assigns overall NSPO as a function of each program's marketing and program budget. This approach remains consistent with the theory that NPSO results from the cumulative effect of program-specific and Act On Energy marketing and program activity over a period of time, not necessarily by a single, program-specific marketing effort. In addition, while NPSO is most commonly associated with mass media marketing campaigns, the scale of program activity also proves to be a factor. For example, even without a significant marketing campaign, a program's size can drive NPSO through word-of-mouth and in-store program messaging. We believe this approach accurately reflects and attributes NSPO to programs, ensuring those total costs (including marketing) and total benefits (net savings including NPSO) are properly accounted for when assessing overall program cost-effectiveness.

The Cadmus team then distributed the portfolio-level result of 7,592 MWh NPSO to Ameren's residential programs (excluding CommunitySavers and ConstructionSavers). As noted, we considered both the PY13 program size (in terms of total gross *ex post* MWh savings) and each program's marketing budget (shown in Table 31**Error! Reference source not found.**) when allocating NPSO across programs.

Table 31. Program-Specific Savings and Marketing

Program	Program *Ex Post* Gross Savings (MWh)	Percentage of Portfolio Savings	Total Marketing	Percentage of Total Marketing
ApplianceSavers	6,963	2.6%	$542,242	35.1%
CoolSavers	**25,098**	**9.4%**	**$824,949**	**53.4%**
LightSavers	227,132	84.8%	$33,146	2.1%
PerformanceSavers	316	0.1%	$73,145	4.7%
RebateSavers	8,409	3.1%	$71,788	4.6%
Total	**267,918**	**100%**	**$1,545,270**	**100%**

The results of this approach (shown in Table 32 and Table 33) reflect the impact of each program on the nonparticipant population, based on marketing expenditures and program magnitudes in the marketplace.

Table 32. Combined Savings and Marketing Allocation Approach

Program	*Ex Post* Gross Energy Savings (A)	Marketing Spending (B)	Combined Savings/Marketing (AxB)	Percentage of Combined Savings/Marketing
ApplianceSavers	2.6%	35.1%	0.9%	11.6%
CoolSavers	**9.4%**	**53.4%**	**5.0%**	**63.4%**
LightSavers	84.8%	2.1%	1.8%	23.1%
PerformanceSavers	0.1%	4.7%	0.006%	0.07%
RebateSavers	3.1%	4.6%	0.1%	1.8%
Total	**100%**	**100%**	**7.9%**	**100%**

Two programs are credited with the greatest NPSO: CoolSavers (accounting for one-half of all marketing dollars) at 4,816 MWh; and LightSavers (accounting for more than 80% of total energy savings) at 1,751 MWh. As NPSO impacts program-specific NTG results,[28] all NPSO estimates have been reported as a percentage of each program's total gross energy savings.

As shown in Table 33, we allocated 4,816 MWh of NPSO to CoolSavers, representing 63.4% of the combined residential portfolio savings and marketing expenditure. This resulted in a 19.2% adjustment to the program's PY13 NTG.

Table 33. NPSO by Program

Program	Program Gross Savings (MWh)	Total NPSO (MWh)	Percentage of Combined Savings/Marketing	Program-Specific NPSO (MWh)	NPSO as a Percentage of Gross Savings
ApplianceSavers	6,963		11.6%	878	12.6%
CoolSavers	**25,098**		**63.4%**	**4,816**	**19.2%**
LightSavers	227,132	**7,592**	23.1%	1,751	0.8%
PerformanceSavers	316		0.07%	5	1.7%
RebateSavers	8409		1.8%	140	1.7%
Total	**267,918**		**100%**	**7,592**	**2.8%**

NTG Summary

To estimate CoolSavers PY13 net-to-gross (NTG) ratios, the Cadmus team used the following formula:

NTG = 1.0 – Free Ridership + Participant Spillover + Nonparticipant Spillover + Market Effects

[28] NTG = 1 – Free Ridership + Participant Spillover + NPSO + Market Effects

For the PY13 evaluation, we estimated the first three NTG elements, but not market effects. Since the program is likely to generate market effects—program staff will work closely with local contractors and distributors to improve installation and stocking practices—we plan to estimate the market effect as part of the PY14 evaluation.

Free riders are customers who would have purchased the same high-efficiency CAC or had their existing system tuned up similarly, independently of the program. They account for some costs but none of the program benefits, thereby decreasing CoolSavers' net savings. We estimated free ridership by asking CoolSavers survey respondents a battery of questions regarding their purchasing decisions.

Spillover is: additional savings generated when program participants undertake additional energy-efficient measures or activities without financial assistance due to their experience participating in a program. Unlike free ridership, no program costs are associated with spillover savings, but energy-saving benefits result that increase CoolSavers' net savings. Similar to free ridership, we estimated spillover using a battery of survey questions that assessed whether their energy-efficient actions were: (1) influenced by participation in the CoolSavers program; and (2) not encouraged through incentives of another Ameren Missouri program. This section discusses the Cadmus team's methodology for calculating net savings by measure; net impact calculations are shown in Table 34.

Table 34. PY13 CoolSavers NTG Summary

Program Measure	Percent of Program Energy Savings*	Free Ridership	Participant Spillover	NPSO	NTG Ratio†
New HVAC Install and ECM	94.0%	22.7%	1.4%	19.2%	95.9%
Tune-Up	4.5%	36.6%			84.0%
Programmable Thermostats	1.5%	22.7%			97.6%
Overall			**1.4%**	**18.8%**	**95.4%**

*Based on the Cadmus team's PY13 preliminary gross evaluated savings.

BENCHMARKING

The Cadmus team researched other utilities that offered measures similar to those in Ameren's CoolSavers program. Table 35 compares—by measure type—those utilities' the participation levels and gross and net savings with those of Ameren.

Table 35. CoolSavers Measure Benchmarking

Utility, Program, or Region	Source	Partici-pation	Gross Program Savings (MWh/yr)	Net Per Unit Savings (kWh/yr)
Early Replacement CACs and HPs				
CheckMe! (Ameren)	Entire program (PY09-PY11)	2,917	2,275	1,820
Ameren CoolSavers	PY13	2,622	16,809	2,682
Ameren Illinois	Ameren Illinois PY10 HVAC Draft Report_Final	3,865	5,845	953
Ameren Illinois	PY11 HVAC Report 020112	7,809	11,845	895
Ohio Utility (2010)		4,185	8,867	2,119
Ohio Utility (2011)		3,443	7,200	2,091
AZ Utility		1,592	3,056	1,631
Replace on Burnout CACs and HPs				
CheckMe! (Ameren)	Entire program (PY09-PY11)	198		291
Ameren CoolSavers	PY13 (CACs only)	388	670	364
Ameren Illinois 2009	Ameren Illinois PY10 HVAC Draft Report_Final	1,116	417	263
Ameren Illinois 2010	PY11 HVAC Report 020112	1,699	634	374
Ameren Illinois 2011	AIC PY12 HVAC Report FINAL 2013-03-04			260
Ohio Utility (2010)		187	174	371
Ohio Utility (2011)		143	132	368
AZ Utility		871	957	934
ECM Motors				
CheckMe! (Ameren)	Entire program (PY09-PY11)	28	159	159
Ameren CoolSavers	PY13	4,904	3,755	766
WI Utility		7,812		515
WA Utility		3,687	1,617	439
Tune-Ups (Assuming Refrigerant Charge Adjustment)				
CheckMe (Ameren)	Entire program (PY09-PY11)	1,218		546
Ameren CoolSavers	PY13	4,020	1,139	283
ComEd 2009	ComEd_Central_AC_Efficiency_Services_PY2_Evaluation_Report_Final	16,293		100

Utility, Program, or Region	Source	Partici-pation	Gross Program Savings (MWh/yr)	Net Per Unit Savings (kWh/yr)
ComEd 2010	ComEd_Central_AC_Efficiency_Services_PY3_Evaluation_Report_Final	14,550		101
ComEd 2011	ComEd_Central_AC_Eff_Services_EPY4_Eval_Report_Final	9,973		214
Ohio Utility (2010)		612		191
Ohio Utility (2011)		358		298
Arkansas Utility		3101	2658	780

COST-EFFECTIVENESS RESULTS

To analyze the cost-effectiveness of the PY13 CoolSavers program, MMP utilized DSMore, assessing cost-effectiveness using the following five tests, as defined by the California Standard Practice Manual:[29]

- Total Resource Cost (TRC)
- Utility Cost Test (UCT)
- Ratepayer Impact Measure (RIM)
- Participant Test (PART)
- Societal Test

DSMore takes hourly prices and hourly energy savings from specific measures installed through CoolSavers, and correlates prices and savings to 30 years of historic weather data. Using long-term weather ensures the model captures low probability, high consequence weather events and appropriately values them. As a result, the model's produces an accurate evaluation of demand-side efficiency measures relative to other alternative supply options.

Key assumptions include:

- Discount Rate = 6.95%
- Line Losses = 5.72%
- Summer Peak would occur during the 16th hour of a July day, on average.
- Avoided Electric Transmission & Distribution T&D = $31.01/kW
- Escalation rates for different costs occur at the component level, with separate escalation rates for fuel, capacity, generation, T&D, and customer rates carried out over 25 years.

In addition, MMP leveraged the "Batch Tools" (model inputs) used by Ameren in its original analysis as input into the *ex post* DSMore analysis. By starting with the original DSMore Batch Tool used by Ameren and modifying it only with new data from the evaluation (PY13-specific CoolSavers participation counts, per-unit gross savings, and NTG), consistency was assured. In particular, measure load shapes drove the assumptions in the model, telling the model when to apply savings during the day. This assured: the load shape for that end use matched the system peak impacts of that end use; and provided the correct summer coincident savings. MMP used measure lifetime assumptions and incremental costs based the program's database, the Ameren Missouri TRM, or the original Batch Tool.

A key step in the analysis process was acquiring PY13 Ameren program spending data: actual spending broken down into implementation, incentives, and administration costs. MMP applied these numbers at the program level, not the measure level. While applying incentives at the measure level can be useful for planning purposes, it is unnecessary for cost-effectiveness modeling as the results are based on the

[29] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*. October 2001.

program overall. MMP applied administrative costs (evaluation, potential study costs, and data tracking) in the portfolio summary analysis, not by program as they apply to the whole residential effort.

Table 36 summarizes the cost-effectiveness findings by test. Any benefit/cost score above 1.0 passed the test as cost-effective. The table also includes the cost of conserved energy (CCE), which describes the costs of acquiring those savings, based on the lifetime benefits. In addition, the table includes the present value of the net lifetime benefits (net avoided costs minus program costs). As shown, the CoolSavers program passed the TRC, UCT, PART, and Societal TRC tests. The CCE is $0.016 per kWh and net lifetime benefits are $12,487,110.

Table 36. Cost-Effectiveness Results (PY13)

	TRC	UCT	RIM	PART	Societal	CCE: $/kWh	Net Lifetime Benefits
CoolSavers	2.12	4.76	0.81	2.95	2.60	$0.016	$12,487,111

APPENDIX A. *EX POST* DEMAND REDUCTIONS

The evaluation team determined *ex post* demand savings for all CAC and HP measures reported in the CoolSavers program with the following equation:

$$kW\ saved\ = 12\frac{kBTU}{ton} \times tons \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{efficient}}\right) \times cf$$

We used the metered coincidence factor (73.9%) observed during the peak period which occurred on August 30th during the hour from 4-5pm.

For ECM measures the evaluation team determined *ex post* demand savings were 0 kW. There are no demand savings for ECM fan measures because the efficiency rating of the HVAC unit includes the efficiency improvement from the ECM fan. The team was unable to estimate savings for the few ECM fans that were not installed in conjunction with an air conditioner because we do not know how these ECM fans are used – we only know they are installed with a gas furnace.

For the thermostat setback and generic tune-up measure, the evaluation team determined *ex post* demand reductions using the *ex post* energy savings estimated in this PY13 report and DSMore (using load shapes provided by Ameren). Table 37 lists demand savings by measure type.

Table 37. PY13 Summary: Net *Ex Post* Per-Unit Demand Reductions

Measure	PY13 Participation	Per-Unit Net *Ex Post* Demand Reduction (kW)	Total Net *Ex Post* Savings (kW)*
HPs	759	1.56	1,185
CACs	5,895	1.98	11,669
Diagnostic Tune-Up	4,020	0.17	697
ECMs	4,904	0.00	0
Programmable T-Stats	4,473	0.02	96
Ground Source HPs	84	2.22	186
Total	**20,135**	**n/a**	**13,833**

***Includes savings for early replacement measures based on six-year remaining useful life.

APPENDIX B. STAKEHOLDER INTERVIEW GUIDE

Respondent name:_____

Respondent phone: _____

Interview date: _____ Interviewer initials: _____

For the PY5, PY6 and PY7 evaluations, Cadmus will interview stakeholders bi-annually. The first interview (Wave 1) will focus on the program's launch and changes to the previous program design. The second interview (Wave 2) will assess the program at year end and identify recommendations for improving subsequent programs. In general, the first interview will focus more prospectively, while the second interview is more retrospective.

A. Introduction

1) What are your main responsibilities for the CoolSavers Program?

2) How is communication, both formal and informal, between ICF and Ameren conducted?

3) How does ICF communicate with HVAC contractors?

B. Program Design and Implementation

4) What would you say is working particularly well so far in PY5? Why is that?

5) Conversely, what is not working as well as anticipated? Why is that?

6) Have there been any lessons learned from the PY5 launch?

C. Program Goals

7) What are the program's participation and savings goals for PY5?

8) Does the program have any process or non-impact goals for PY5? (Probe: increased awareness, market transformation, spillover measures such as duct sealing or insulation)?

9) In your opinion, how has the program performed so far in PY5 (in terms of both process and savings/participation goals)?

10) Why do you think this is?

D. Contractor Training and Participation

11) We understand that the implementer offers program training for contractors. Do you believe these trainings are effective? In what way?

12) The program also offers a technical training for contractors that is not a requirement of program participation. Do you believe this is effective?

13) Do you believe contractor participation is currently on track?

14) To what extent do you believe the training, and involvement in the program, is impacting the region's standard HVAC diagnostic, sizing, and efficiency practices?

E. Quality Control

15) In your own words, please explain how the program's quality control process works.

16) Does Ameren perform any ride-alongs or independent quality control checks? Please explain.

F. Measures

17) In your opinion, should any additional measures be considered for inclusion in future programs? If so, what measures? Did HVAC contractors regularly request a specific measure not included in the program? If so, what measure? Did home-owners?

18) Conversely, should any current measures be excluded?

19) How were incentive amounts determined?

G. Marketing Efforts

20) What kind of marketing have you done so far in PY5? How does this compare to previous program years?

21) We recognize that marketing methods are designed to work in concert and collectively encourage participation, but do you feel that any of these strategies have been particularly effective or ineffective so far?

22) Do you have any ideas for improving marketing in the future?

H. Customer and Contractor Feedback

23) Are there any recurring or common customer praises or complaints? If so, what are they?

24) How are customers' problems and questions dealt with?

25) Have you had many customers or contractors dissatisfied with the program? If so, why?

26) Have any contactors elected to drop out of the program or have any contractors mentioned they do not plan to participate? If so, why?

I. Summary

27) From your perspective, what are the biggest challenges facing the program in PY5?

28) Is there anything else you'd like us to know about your experience administrating/implementing the program so far this year?

720 SW Washington Street
Suite 400
Portland, OR 97205
Voice: 503.467.7100
Fax: 503.228.3696

29) Cadmus is reaching out to program stakeholders earlier in the year for PY5 to figure out how each stakeholder group can best benefit from the program evaluation process. Is there anything specific you were hoping to learn from this evaluation?

30) Is there anything else you'd like us to know?

720 SW Washington Street
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Fax: 503.228.3696

APPENDIX C. PARTICIPANT SURVEY INSTRUMENTS

TUNE-UP PARTICIPANT SURVEY

A. Introduction

Hello, my name is _____ and I'm calling on behalf of Ameren Missouri. I am calling to ask some questions about your household's participation in Ameren Missouri's CoolSavers program which provides incentives for HVAC tune-ups.

May I please speak with [PARTNAME]? Your program application indicates he/she worked with [CONTRACTORNAME] who performed your tune-up.

[IF NEEDED: I'm NOT calling about your utility bill or selling anything.**]**

[IF PERSON DOES NOT RECOGNIZE THE PROGRAM: You may remember your contractor recommending a CoolSavers tune-up when servicing your heating and cooling equipment and a discount offered by your utility Ameren to offset the cost of this advanced service. Does this sound familiar now?**]**

[IF RESPONDENT ASKS HOW LONG, SAY "ABOUT 15 MINUTES."]

[IF NO ONE IS FAMILIAR WITH THE INSTALLATION IS AVAILABLE, TRY TO RESCHEDULE, AND THEN TERMINATE.]

[IF TRANSFERRED TO ANOTHER PERSON, REPEAT INTRO AND THEN CONTINUE.]

B. Verification and Program Awareness

B1. Our records indicate that you received a rebate for a CoolSavers tune-up performed in **[MONTH]**. Does this sound right?

1. Yes
2. No **[PROBE; ASK WHICH MEASURES RECEIVED, IF DIFFERENT. ASK ABOUT OTHER PEOPLE IN THE HOUSEHOLD WHO MIGHT BE FAMILIAR. IF NOT RESOLVED, RECORD VERBATIM RESPONSE TO PROMPT: "WHAT IS INCORRECT?" AND THEN TERMINATE]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]** **[THANK AND TERMINATE]**

B2. Were you aware that the rebate you received for your tune-up was provided by Ameren Missouri?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B3. How did you first hear about Ameren's CoolSavers program? **[DO NOT PROMPT. ACCEPT ONE ANSWER ONLY]**

1. From my contractor
2. Visited Ameren's Web site
3. Other Web site [**SPECIFY:**_____]
4. Bill insert/information came in the mail with my bill
5. When my rebate check arrived
6. Door hanger
7. Friend, family member, colleague
8. Newspaper
9. Radio
10. Ameren Missouri representative
11. Social Media (Facebook, Twitter)
12. Other [**SPECIFY:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B4. Did you hear about the program through other sources as well?

1. Yes, how? **[SAME OPTIONS ARE B3, DO NOT READ, MARK ALL THAT APPLY]**
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B5. What motivated you to purchase this service? **[DO NOT READ LIST; INDICATE ALL THAT APPLY] [CODE VARIABLES AS FIRST MENTION, SECOND MENTION, ETC.][ONCE THE RESPONDENT HAS FINISHED, PROBE:** Are there any other factors?**]**

1. My air conditioner stopped working (i.e., unit failed)
2. My air conditioner was working, but was having problems (i.e., wasn't cooling properly or was making a noise)
3. Maintenance contract / Regularly scheduled check up
4. To take advantage of the rebate
5. It was time for a tune-up
6. To ensure that it lasts longer
7. To find out if it needs any repairs
8. To keep my air conditioner running efficiently
9. To save energy
10. To lower energy bill, save money on bills
11. It didn't cost much
12. Reminded by Ameren Missouri advertising.
13. Reminded by advertising other than Ameren Missouri
14. Recommended by a family or friend
15. Other [**SPECIFY:**_____]

98. DON'T KNOW **[DO NOT READ]**
98. REFUSED **[DO NOT READ]**

C. Participation Process

C1. How did you select the contractor who performed the tune-up? **[DO NOT READ LIST; INDICATE UP TO THREE]**

1. I used a contractor I have used before
2. The contractor approached me about the program
3. Ameren website
4. Referred by Family/Friend /Colleague
5. Online Internet ad [**SPECIFY SOURCE:** _____]
6. Newspaper/TV/Radio advertisement
7. Through business owners in my neighborhood or network
8. Yellow pages
9. HVAC Contractor advertising
10. Consumer's Report/Angie's List or Similar consumer information source
11. Better Business Bureau
12. Other [**SPECIFY:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

C2. **[SKIP IF C1 = 2, 98, 99**] Did you intentionally seek out a CoolSavers participating contractor?

1. Yes
2. No **[SKIP TO C4]**

98. DON'T KNOW **[DO NOT READ] [SKIP TO C4]**
99. REFUSED**[DO NOT READ] [SKIP TO C4]**

C3. How difficult was it to find a contractor that was qualified to provide services for the CoolSavers Program? Would you say it was…**[READ LIST]**

1. Not at all difficult
2. Not too difficult
3. Somewhat difficult
4. Very difficult

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

C4. I'm going to read a list of items. For each, please tell me if your contractor discussed the item with you prior to tuning up your system. **[READ ALL OPTIONS; ALLOW MULTIPLE RESPONSES]**

1. Rebates or incentives for high efficiency tune-ups from Ameren
2. Rebates or incentives for equipment upgrades from Ameren
3. Additional energy-efficient equipment or home improvements
4. Energy saving tips

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

C5. Did your contractor recommend replacing your A/C unit or heat pump with a new high efficiency unit?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

C6. **[IF C5=1]** Why did you choose to tune-up your system rather than replace it?

1. Expect the system to last for the foreseeable future
2. The system is still efficient enough
3. I don't want to invest the money in a new system yet
4. Purchasing a new system is wasteful
5. Never considered that an option

98. DON'T KNOW **[DO NOT READ]**

99. REFUSED **[DO NOT READ]**

D. Participant Satisfaction

D1. How satisfied are you with the CoolSavers contractor you worked with? Are you… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

98. DON'T KNOW **[DO NOT READ]**

99. REFUSED **[DO NOT READ]**

D2. How satisfied are you with the performance of your system since the tune-up? Are you…**[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

98. DON'T KNOW **[DO NOT READ]**

99. REFUSED **[DO NOT READ]**

D3. **[IF D2 = 1 OR 2]** Why is that? [**RECORD:** _____]

D6. Since you received your tune-up have you experienced any benefits or noticed changes in your electric bill? **[DO NOT READ. ALLOW MORE THAN ONE RESPONSE.]**

1. Increased energy savings/lower electric bill
2. Increased comfort
3. Increased convenience or productivity
4. Lower maintenance costs
5. Environmental benefits
6. Less waste
7. None
8. Other [**SPECIFY:** _____]
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D7. Thinking back over the scheduling, servicing, available measures, and rebate processes, how satisfied are you with the overall CoolSavers program? Would you say you are… **[READ RESPONSES]**

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D8. **[IF D7 = 3 OR 4]** For what reason were you less than very satisfied with the program?**[DO NOT READ, ALLOW MULTIPLE RESPONSE]**

1. The discount didn't cover enough of the cost
2. The commissioning rebate took too long to get
3. It didn't save me any money on my bills
4. It took too long to perform the service
5. Contractor showed up late
6. Contractor was unreliable/unprofessional
7. The equipment doesn't work well
8. I wanted to use a different (non-program) contractor
9. Other [**SPECIFY:** _____]
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D9. Would you recommend Ameren's CoolSavers program to friends or family members?

1. Yes
2. No
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D10. Do you have any suggestions for how Ameren could improve the CoolSavers program?

1. Yes [**RECORD VERBATIM:** _____]
2. No
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E. Free Ridership

E1. Do you currently have a maintenance contract for your HVAC system?

1. Yes
2. No **[SKIP TO E3]**

98. DON'T KNOW **[DO NOT READ]** **[SKIP TO E3]**
99. REFUSED **[DO NOT READ]** **[SKIP TO E3]**

E2. Did your regular maintenance contractor provide the CoolSavers tune-up as part of your maintenance contract or annual check-up?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E3. When you first heard of the Ameren discount, had you already scheduled your tune-up or annual check-up?

1. Yes
2. No **[SKIP TO E5]**

98. DON'T KNOW **[DO NOT READ]** **[SKIP TO E5]**
99. REFUSED **[DO NOT READ]** **[SKIP TO E5]**

E4. To confirm, you scheduled the tune-up or check-up and then found out about the Ameren discount, is that correct?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E5. Did the contractor explain what was different about a CoolSavers tune-up from their standard tune-up?

1. Yes
2. No **[SKIP TO E7]**
3. Explained there was no difference **[SKIP TO E7]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]** **[SKIP TO E7]**

E6. **[IF E5=1]** What did they say was different? **[ACCEPT MULTIPLE RESPONSES]**

1. Checked airflow
2. Checked/adjusted refrigerant charge
3. Cleaned indoor coil
4. Cleaned outdoor coil
5. Other [**RECORD:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E7. If the $75 discount provided by Ameren had not been available, would you have still purchased a tune-up at full cost?

1. Yes, would have purchased CoolSavers tune-up
2. No, would not have purchased the CoolSavers tune-up

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E8. Without the discount, would you have had the CoolSavers tune-up performed…? **[READ LIST]**

1. Sooner
2. At the same time
3. Later in the same year
4. In one to two years
5. More than two years
6. Or would not have done at all?

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E9. Could you please explain in your own words the importance of the Ameren discount on your decision to have a CoolSavers tune-up performed instead of a standard tune-up?

1. [**RECORD VERBATIM:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F. Spillover

F1. Since participating in the program, have you added any other energy-efficient products in your **[HOME/BUSINESS]** or had any other energy-related services performed that were not discounted through Ameren?

1. Yes
2. No **[THANK AND TERMINATE]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F2. **[IF F1=1]** Please describe the types of the products you have added or energy-related services performed. **[DO NOT READ LIST, MARK ALL THAT APPLY]**

1. Performed a home/building audit
2. Recycled a refrigerator or freezer
3. Constructed an Energy Star New Home
4. Purchased CFLs? [**ASK:** How many? _____]
5. Purchased LED light bulbs? [**ASK:** How many? _____]
6. Purchased Light fixtures or ceiling fan [**ASK:** How many? _____]
7. Purchased efficient refrigerator
8. Purchased efficient freezer
9. Purchase efficient clothes washer
10. Purchased efficient dishwasher
11. Purchased efficient room air conditioner [**ASK:** How many? _____]
12. Purchased energy efficient electronics (e.g. TV, DVD, computer)
13. Purchased efficient dehumidifier
14. Purchased efficient water heater
15. Installed a low flow showerhead or faucet aerator [**ASK:** How many? _____]
16. Purchase and programmed a programmable thermostat
17. Installed insulation
18. Installed solar panels
19. Other [**SPECIFY VERBATIM:** _____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F3. Why did you choose to install these products or perform these actions?

1. **[RECORD RESPONSE]**:_____

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F4. Did you receive a rebate, discount, or tax credit for making this improvement?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F5. **[IF F4 = 1]** From what organization?

1. [**RECORD RESPONSE:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F6. Prior to purchasing or installing **[F1 RESPONSE],** had you heard or read about the benefits of **[F1 RESPONSE]** from your CoolSavers contractor, Ameren, or Ameren's Act on Energy campaign?

1. Yes
2. No **[SKIP TO J1]**

98. DON'T KNOW **[DO NOT READ]** **[SKIP TO J1]**
99. REFUSED **[DO NOT READ]** **[SKIP TO J1]**

F7. How important was the information the contractor or Ameren provided about the energy efficiency benefits of **[F1 RESPONSE]** in your decision to take this energy improvement? Would you say it was…**[READ RESPONSES]**

1. Not at all important
2. Not too important
3. Somewhat important
4. Very important
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F8. How satisfied are you with Ameren as an electric service provider? **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

J. Customer Demographics

J1. Thinking about your overall experiences with Ameren Missouri as your utility, how satisfied would you say you are with Ameren Missouri? Would you say you are…**[READ RESPONSES; SELECT ONE RESPONSE]**

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J2. Based on your experience with the CoolSavers program, would you say your opinion of Ameren Missouri… [READ LIST]

1. Increased,
2. Stayed about the same, or
3. Decreased?
98. (Don't know)
99. (Refused)

J3. Is your hot water heater electric or gas?

1. Electric
2. Gas
-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J4. What type of home do you live in? **[READ RESPONSES; SELECT ONE RESPONSE]**

1. Single-family home **[NOT A DUPLEX, TOWNHOME, OR APARTMENT; ATTACHED GARAGE IS**

OK]

2. Manufactured or modular
3. Mobile home
4. Row house/townhome
5. Two or three family attached residence
6. Apartment with 4 units or greater
7. Condominium
8. Other [**SPECIFY:** _____]

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J5. Approximately how many square feet of living space does your home have? Don't include the basement unless it is a space that you consider lived in.

1. Less than 1,000 square feet
2. 1,000 to less than 1,500 square feet
3. 1,500 to less than 2,000 square feet
4. 2,000 to less than 2,500 square feet
5. 2,500 to less than 3,000 square feet
6. 3,000 or more square feet

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J6. When was your home built? Was it… **[READ ALL, THEN RECORD]**

1. After 2008
2. 2005-2008
3. 2001-2004
4. 1980-2000
5. Before 1980

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J7. Do you own or rent this residence?

1. Own
2. Rent

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

THANK AND TERMINATE

This completes the survey. Your responses are very important to Ameren and will help as we design future energy efficiency programs. We appreciate your participation and thank you for your time. Have a good evening/day.

Replacement Participant Survey

A. Introduction

Hello, my name is [_____], and I am calling on behalf of Ameren Missouri. I am calling to ask some questions about your recent experience with Ameren's CoolSavers Program for air-conditioners and heat pumps. All your answers are confidential.

May I please speak with [PARTNAME]? Your program application indicates he/she worked with [CONTRACTORNAME] to install your new air conditioner.

[IF NEEDED: I'm NOT calling about your utility bill or selling anything.**]**

[IF PERSON DOES NOT RECOGNIZE THE PROGRAM: You may remember your contractor recommending a high efficiency HVAC system and a discount offered by Ameren to offset the cost of this installation. Does this sound familiar?**]**

[IF RESPONDENT ASKS HOW LONG, SAY "ABOUT 15 MINUTES."]

[IF NO ONE IS FAMILIAR WITH THE INSTALLATION IS AVAILABLE, TRY TO RESCHEDULE AND THEN TERMINATE.]

[IF TRANSFERRED TO ANOTHER PERSON, REPEAT INTRO AND THEN CONTINUE.]

B. Verification and Program Awareness

B1. Our records indicate that you received a rebate for installing a new high efficiency **[MEASURETYPE]**. Does this sound right?

1. Yes
2. No **[PROBE; ASK WHICH MEASURES RECEIVED, IF DIFFERENT. ASK ABOUT OTHER PEOPLE IN THE HOUSEHOLD WHO MIGHT BE FAMILIAR. IF NOT RESOLVED, RECORD VERBATIM RESPONSE TO PROMPT: "WHAT IS INCORRECT?" AND THEN TERMINATE]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ] [THANK AND TERMINATE]**

B2. Were you aware that the rebate you received after install your new high efficiency **[MEASURETYPE]** was provided by Ameren Missouri?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B3. How did you first hear about Ameren's CoolSavers program? **[DO NOT READ - ONE ANSWER ONLY]**

1. From my contractor
2. Visited Ameren's Web site
3. Other Web site **[SPECIFY:_____]**
4. Bill insert/information came in the mail with my bill
5. When my rebate check arrived
6. Door hanger
7. Friend, family member, colleague
8. Newspaper
9. Radio
10. Ameren Missouri representative
11. Social Media (Facebook, Twitter)
12. Other **[SPECIFY:_____]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B4. Did you hear about the program through other sources as well?

1. Yes, how? **[SAME OPTIONS AS B3, DO NOT READ, MARK ALL THAT APPLY]**
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

C. Participation Process

B1. How did you select the contractor who installed your system? **[DO NOT READ LIST; RECORD UP TO THREE REPONSES]**

1. I used a contractor I have used before
2. The contractor approached me about the program
3. Ameren provided referrals to me.
4. Ameren website
5. Referred by Family/Friend /Colleague
6. Online Internet ad **[SPECIFY: _____]**
7. Newspaper/TV/Radio advertisement
8. Through business owners in my neighborhood or network
9. Yellow pages
10. HVAC Contractor advertising
11. Consumer's Report/Angie's List or Similar consumer information source
12. Better Business Bureau
13. Other **[SPECIFY:_____]**

98. DON'T KNOW **[DO NOT READ]**
98. REFUSED **[DO NOT READ]**

B2. **[SKIP IF C1 = 2, 98, 99]** Did you specifically seek out a contractor that participated in the CoolSavers program?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B3. **[IF C2=1]** How difficult was it to find a contractor that participated in the CoolSavers Program? Would you say it was… **[READ LIST]**

1. Not at all difficult
2. Not too difficult
3. Somewhat difficult
4. Very difficult

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B4. I'm going to read a list of items. For each, please tell me if your contractor discussed the item with you prior to installing the new system. **[READ ALL OPTIONS; ALLOW MULTIPLE RESPONSES]**

1. Rebates for high efficiency equipment from Ameren
2. Contractor or manufacturer rebates
3. State or federal tax credits or rebates
4. Additional energy-efficient equipment or home improvements
5. Energy saving tips

98. DON'T KNOW **[DO NOT READ]** **[SKIP TO SECTION D]**
99. REFUSED **[DO NOT READ]** **[SKIP TO SECTION D]**

B5. **[ASK IF C4 = 2]** How much was contractor or manufacturer rebate you received?

1. **[RECORD RESPONSE:_____]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

B6. **[ASK IF C4 = 3]** How much was tax credit you have received or will receive?

1. **[RECORD RESPONSE:_____]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D. Participant Satisfaction

D1. How satisfied are you with the contractor you worked with? Are you…**[READ LIST]**?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D2. **[IF D1 = 3 OR 4]** Why is that? [**RECORD:** _____]

D3. How satisfied are you with the performance of your new system? Are you…**[READ LIST]**

1. Not at all satisfied
2. Not too satisfied
3. Somewhat satisfied
4. Very satisfied

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D4. **[IF D3 = 1, 2]** Why is that? [**RECORD:** _____]

D5. Thinking back over the scheduling, servicing, available measures, and rebate processes, how satisfied are you with the overall Ameren CoolSavers program? Would you say you are? **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D6. **[IF D7 = 3 OR 4]** For what reason were you less satisfied with the program? **[DO NOT READ; MARK ALL THAT APPLY]**

1. The discount didn't cover enough of the cost
2. The rebate took too long to arrive
3. It didn't save me any money on my bills
4. It took too long to perform the service
5. Contractor showed up late
6. Contractor was unreliable/unprofessional
7. The equipment doesn't work well
8. I wanted to use a different (non-program) contractor
9. Other [**SPECIFY:**_____]
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D7. Would you recommend Ameren's CoolSavers program to friends or family members?

1. Yes
2. No
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

D8. What suggestions, if any, do you have for improving the program?
[**RECORD RESPONSE:**_____]

E. Early Replacement

[ASK SECTION E ONLY IF PARTTYPE = "EARLYREPLACE", OTHERWISE SKIP TO SECTION F]

E1. Please think back when your contractor first visited your home. What prompted the visit? **[DO NOT READ LIST; INDICATE ALL THAT APPLY]** **[CODE VARIABLES AS FIRST MENTION, SECOND MENTION, ETC.]** **[ONCE THE RESPONDENT HAS FINISHED, PROBE:** Are there any other factors?**]**

1. My air conditioner stopped working (i.e., unit failed)
2. My air conditioner was working, but was having problems (i.e., wasn't cooling properly or was making a noise)
3. Maintenance contract / Regularly scheduled check up
4. To take advantage of the rebate

5. It was time for a tune-up
6. To ensure that it lasts longer
7. To find out if it needs any repairs
8. To keep my air conditioner running efficiently
9. To save energy
10. To lower energy bill, save money on bills
11. It didn't cost much
12. Reminded by Ameren Missouri advertising.
13. Reminded by advertising other than Ameren Missouri.
14. Recommended by a family or friend
15. Other [**SPECIFY:**_____]

98. DON'T KNOW **[DO NOT READ]**
98. REFUSED **[DO NOT READ]**

E2. Did your contractor offer you the option to repair or tune-up your system instead of replacing it?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E3. **[IF E2 = 2]** So, to the best of your knowledge your system was not repairable and had to be replaced?

1. Yes
2. No

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E4. **[IF E2 =1 OR E3=2]** About how much would the repair have cost?

1. [**RECORD ANSWER:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E5. **[IF E2 = 1]** Why did you opt for replacing the unit instead of repairing it? **[DO NOT READ; MARK ALL THAT APPLY]**

1. The repair costs were too much; was not worth it
2. I would have had to replace it soon anyway
3. The contractor convinced me installing a high-efficiency model was worth it/ would save me money in the long-run
4. I wanted to take advantage of Ameren's rebates while available
5. I wanted to take advantage of manufacturer rebates or tax credits while available
6. Other [**SPECIFY:**_____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F. Heat Pumps

[ASK SECTION F ONLY IF MEASURETYPE = "HEAT PUMP", OTHERWISE SKIP TO SECTION G]

F1. Before you knew about the heat pump incentive from Ameren, were you already considering a heat pump as your replacement system?
1. Yes
2. No
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F2. **[IF F2 = 1]** Why were you considering a heat pump? **[DO NOT READ]**
1. It was more efficient
2. I wanted heating as well
3. I knew about Ameren's incentive
4. Other [**SPECIFY:**_____]
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F3. **[IF F2 = 2]** Why did you decide to install a heat pump?
1. It was more efficient
2. I wanted heating as well
3. I found out about Ameren's incentive
4. The contractor told me about Ameren's incentive
5. The contractor told me about the benefits of a heat pump
6. Other [**SPECIFY:**_____]
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

G. Free Ridership

G1. **[IF MEASURETYPE = "CAC"]** Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?
1. Yes
2. No
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

G2. Do you know the efficiency or SEER rating of your HVAC system installed?
1. Yes [What SEER? **RECORD:** _____]
2. No **[SKIP TO G6]**
98. DON'T KNOW **[DO NOT READ, SKIP TO G6]**
99. REFUSED **[DO NOT READ, SKIP TO G6]**

G3. **[IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?
1. Yes [What SEER? **RECORD:** _____]
2. No **[SKIP TO G6]**
98. DON'T KNOW **[DO NOT READ, SKIP TO G6]**

99. REFUSED **[DO NOT READ, SKIP TO G6]**

G4. **[IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[DO NOT READ; MARK ALL THAT APPLY]**

1. I wanted the cheapest option available
2. I wanted the most efficient option possible
3. I researched my options and decided this was the right balance of efficiency and cost
4. My contractor convinced me this was the right balance of efficiency and cost
5. I heard Ameren provided an incentive for this SEER
6. It's the same efficiency as my old unit
7. I wanted something more efficient than my old unit
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

G5. **[IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?

1. Not at all important
2. Not very important
3. Somewhat important
4. Very important
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

G6. **[IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?

1. Very important
2. Somewhat important
3. Not very important
4. Not at all important
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

G7. **[IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?

1. Not at all important
2. Not very important
3. Somewhat important
4. Very important
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E8. Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**

1. Lower efficiency
2. Same efficiency
3. Higher efficiency
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

E9. Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**

1. Sooner
2. At the same time
3. Later in the same year
4. In one or two years
5. In three to five years
6. After more than 5 years?

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

H. Spillover

F1. Since participating in the program, have you added any other energy-efficient products in your **[HOME/BUSINESS]** or had any other energy-related services performed that were not discounted through Ameren?

1. Yes
2. No **[THANK AND TERMINATE]**

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F2. **[IF F1=1]** Please describe the types of the products you have added or energy-related services performed. **[DO NOT READ LIST, MARK ALL THAT APPLY]**

1. Performed a home/building audit
2. Recycled a refrigerator or freezer
3. Constructed an Energy Star New Home
4. Purchased CFLs? [**ASK:** How many? _____]
5. Purchased LED light bulbs? [**ASK:** How many? _____]
6. Purchased Light fixtures or ceiling fan [**ASK:** How many? _____]
7. Purchased efficient refrigerator
8. Purchased efficient freezer
9. Purchase efficient clothes washer
10. Purchased efficient dishwasher
11. Purchased efficient room air conditioner [**ASK:** How many? _____]
12. Purchased energy efficient electronics (e.g. TV, DVD, computer)
13. Purchased efficient dehumidifier
14. Purchased efficient water heater
15. Installed a low flow showerhead or faucet aerator [**ASK:** How many? _____]
16. Purchase and programmed a programmable thermostat
17. Installed insulation
18. Installed solar panels
19. Other [**SPECIFY VERBATIM:** _____]

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F3. Why did you choose to install these products or perform these actions?

1. **[RECORD RESPONSE]**:_____

98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F4. Did you receive a rebate, discount, or tax credit for making this improvement?
1. Yes
2. No
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F5. **[IF F4 = 1]** From what organization?
1. [**RECORD RESPONSE:**_____]
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F6. Prior to purchasing or installing **[F1 RESPONSE],** had you heard or read about the benefits of **[F1 RESPONSE]** from your CoolSavers contractor, Ameren, or Ameren's Act on Energy campaign?
1. Yes
2. No **[SKIP TO J1]**
98. DON'T KNOW **[DO NOT READ] [SKIP TO J1]**
99. REFUSED **[DO NOT READ] [SKIP TO J1]**

F7. How important was the information the contractor or Ameren provided about the energy efficiency or money saving benefits of **[F1 RESPONSE]** in your decision to take this energy improvement? Would you say it was…**[READ RESPONSES]**
1. Not at all important
2. Not too important
3. Somewhat important
4. Very important
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

F8. How satisfied are you with Ameren as an electric service provider? Are you…**[READ LIST]**
1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
98. DON'T KNOW **[DO NOT READ]**
99. REFUSED **[DO NOT READ]**

J. Customer Demographics

J1. Thinking about your overall experiences with Ameren Missouri as your utility, how satisfied would you say you are with Ameren Missouri? Would you say you are…**[READ RESPONSES; SELECT ONE RESPONSE]**
1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J2. Based on your experience with the CoolSavers program, would you say your opinion of Ameren Missouri… [READ LIST]

1. Increased,
2. Stayed about the same, or
3. Decreased?
98. (Don't know)
99. (Refused)

J3. Is your hot water heater electric or gas?

1. Electric
2. Gas
-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J4. What type of home do you live in? **[READ RESPONSES; SELECT ONE RESPONSE]**

1. Single-family home **[NOT A DUPLEX, TOWNHOME, OR APARTMENT; ATTACHED GARAGE IS OK]**
2. Manufactured or modular
3. Mobile home
4. Row house/townhome
5. Two or three family attached residence
6. Apartment with 4 units or greater
7. Condominium
8. Other [**SPECIFY:** _____]

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J5. Approximately how many square feet of living space does your home have? Don't include the basement unless it is a space that you consider lived in.

1. Less than 1,000 square feet
2. 1,000 to less than 1,500 square feet
3. 1,500 to less than 2,000 square feet
4. 2,000 to less than 2,500 square feet
5. 2,500 to less than 3,000 square feet
6. 3,000 or more square feet

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J6. When was your home built? Was it… **[READ ALL, THEN RECORD]**

1. After 2008
2. 2005-2008
3. 2001-2004
4. 1980-2000
5. Before 1980

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

J7. Do you own or rent this residence?

1. Own
2. Rent

-98. DON'T KNOW **[DO NOT READ]**
-99. REFUSED **[DO NOT READ]**

THANK AND TERMINATE

This completes the survey. Your responses are very important to Ameren and will help as we design future energy efficiency programs. We appreciate your participation and thank you for your time. Have a good evening/day.

APPENDIX D. CONTRACTOR/DISTRIBUTOR INTERVIEW GUIDES

CONTRACTOR INTERVIEW GUIDE

[**NOTE**: this interview guide is intended for HVAC company managers and technicians that participated in the PY13 CoolSavers program offered by Ameren Missouri and implemented by ICF.]

Hello, my name is _____ and I'm calling from Cadmus, an independent evaluator for Ameren Missouri's CoolSavers program. I am hoping for some of your time to discuss your experience. Please note this is not an audit or evaluation of your personal performance; rather, we are interested in your perspective of the program's strengths and weaknesses so that Ameren Missouri can continually improve the programs it offers to its customers. Anything you say is confidential and we will combine it with responses to similar questions provided by other participating contractors.

[**If asked**: on average, the interview takes approximately 20 minutes. If this isn't a good time, I'd be happy to call you back at another time that works better for you.]

General

1. Please briefly describe the range of services you provide for your customers.
2. How many years has your company been in business?
3. Where are your main offices located?
4. How many technicians does your company employ? [**RECORD:** ____]
5. Do all of your technicians promote the CoolSavers program? If not, approximately what percent do not promote it? [**RECORD:** ____] Why?
6. Do your technicians offer program rebates to every customer? If not, why not?
7. Do your technicians offer both new equipment and tune-up rebates? If not, why not?
8. What were the main reasons you decided to participate in CoolSavers? [**READ RESPONSES, SELECT ALL THAT APPLY]**

    A) Customers asked for the program rebate
    B) To provide rebates to customers
    C) To create additional business opportunities
    D) Competitive advantage
    E) It's the right thing to do
    F) Referred by a participating contractor
    G) Other [**SPECIFY:** _____]

9. What, if any concerns did you have about participating in the program when you first enrolled?
10. How were these concerns resolved?
11. Were there any technical barriers to participating in the program? [**probe:** did you have to buy new equipment? Did any of the technicians require training to properly collect the test data?]

12. Program records show your company has installed ___ new systems and tuned-up ____ existing systems with Ameren rebates as of [most recent data]. About what percent of your company's total new systems and tune-up jobs does this represent?
    A) _____% (new systems)
    B) _____% (tune-ups)

Training

1. Did you or any of your technicians attend the technical training conducted by ICF?
2. If not, why not?
3. Do any plan on attending this training? [if contractor did not attend training, skip to next section: marketing]
4. If yes, did everyone attend?
5. If not everyone attended, what percent attended [**RECORD:** ____] and how did your company decide which technicians would attend?
6. How useful did you find the technical training, would you say it was…[read responses]
    A) Very useful
    B) Somewhat useful
    C) Not too useful
    D) Not at all useful
7. [If "very" or "somewhat useful"] what specifically did you find useful?
8. [If "not too" or "not at all useful"] Why specifically did you think the training was not that useful?
9. Were there any parts of the training you felt could be improved? What specifically?
10. Were there any specific elements of the training you feel improved your ability to serve your clients? If so, what?

Marketing

1. Prior to the CoolSavers program, in what ways did your company promote its services? (**probe**: radio advertisements, T.T. advertisements, newspaper, periodicals, websites)
2. Do you actively advertise the CoolSavers program, beyond just telling customers about incentives while on-site? (**PROBE**: sending out flyers or radio ads)
    A) If yes, what forms of advertising have you used?
3. Are there any other ways your company promotes the program? (**PROBE**: highlight incentives in customer cost proposals, customer education, word-of-mouth, discussion with other contractors)?
4. Of the customers who were aware of the program, how did they hear about it?

Value of Energy Efficiency

1. Prior to the program what type of system (SEER rating) did you promote when attempting to sell a new system? [**RECORD:** ____]
    A) Why was that?
2. Has this changed at all since participating in the CoolSavers?
    A) Why is that?
3. How willing are customers to pay the extra cost for more efficient heating and cooling equipment? Would you say [read]:
    A) Very willing
    B) Somewhat willing
    C) Not very willing
    D) Not at all willing
4. What percent of your customers mention Ameren rebates before you tell them about them? _____%

Program Delivery

1. From your perspective, what are the main reasons some customers did not want to participate in the program?
2. Are there any potential changes to the program that would encourage these customers to participate?
3. Would you like to see the program expanded to include any other energy-efficient products or services? If yes, which products or services?
4. Do customers who participate in the program differ from your typical customers? If so, in what way(s) are they different?
5. How would you rate the application process for <u>new HVAC installations</u>? Would you are you [read]:
    A) Very satisfied
    B) Somewhat satisfied
    C) Not too satisfied
    D) Not satisfied at all
6. How would you rate the application process for tune-up service work? Would you say [read]:
    A) Very satisfied
    B) Somewhat satisfied
    C) Not too satisfied

D) Not satisfied at all

7. If you have needed support or help from the program managers, how has your experience been receiving help or support?

Incentive Levels

1. For each of the following measures, please tell me whether you think the current **customer rebate** is low, high, or just right to motivate your customers to upgrade:
   A) Replacement of existing operational heat pump with new system rated SEER ≥ 14 & < 15: $300 (and $450 if replacing electric furnace) [**RECORD:** ____]
   B) Replacement of existing operational heat pump with new system rated SEER ≥ 15 & < 16: $350 (and $550 if replacing electric furnace) [**RECORD:** ____]
   C) Replacement of existing operational HEAT pump with new system rated SEER ≥ 16: $400 (and $650 if replacing electric furnace) [**record:** ____]
   D) Replacement of existing operational ac with new system rated SEER ≥ 14 & < 15: $250 (and $150 if new install or unit not working) [**RECORD:** ____]
   E) Replacement of existing operational ac with new system rated SEER ≥ 15 & < 16: $350 (and $175 if new install or unit not working) [**RECORD:** ____]
   F) Replacement of existing operational ac with new system rated SEER ≥ 16: $425 (and $200 if new install or unit not working) [**RECORD:** ____]
   G) Diagnostic tune-up: $75 [**RECORD:** ____]
   H) Ground source heat pump: $600 [**RECORD:** ____]
   I) Programmable thermostat: $20 [**RECORD:** ____]
   J) ECM incentives (retrofit: $100, $50 if included in AHRI, $100 if not) [**RECORD:** ____]
2. One of the purposes of the program is to increase customer demand for energy-efficient equipment. Do you feel the program is accomplishing this? Why do you say that?
3. Are your customers more or less interested in purchasing energy-efficient options today than a year ago? Why do you say this?
4. What other factors have affected your sales of energy-efficient products or services?
5. How do the Ameren Missouri rebates affect your stocking practices? (**PROBE:** for example, have you changed your inventory? Increased or decreased inventory of any specific equipment, materials, models, or efficiency levels?)

Informing Tune-Up Free-Ridership

1. How do you market tune-ups to customers?
2. What percentage of the CoolSavers tune-ups were performed on equipment with existing service contracts as part of annual maintenance plans? _____%

3. Has the CoolSavers tune-up incentive encouraged customers to enroll in annual maintenance plans?
4. Do you currently offer different types of tune-ups? Probe:

   A simple Clean and Check? (explain or use table in Q5 to probe)

   Full diagnostic tune-up? (explain or use table in Q5 to probe)
5. Tell me about your tune-up process before the CoolSavers program was available. If needed, use the table to probe:

Element	**Probes**	**Notes**
Condenser coil Cleaning	What is your coil cleaning process? Do you always clean the condenser coil or clean only when it seems dirty? Do you clean both inside and outside the coil? Do you clean the condenser more often when performing a CoolSavers tune-up? (Explain)	
Evaporator coil Cleaning	How do you determine whether the evaporator coil needs cleaning? What is your coil cleaning process? Has this process changed with the CoolSavers program? (probe: frequency, time to perform maintenance)	
Refrigerant Charge	For a typical tune-up we've found that many contractors do not test refrigerant charge if the unit seems to be sufficiently cooling. For a tune-up before the program, did you always check refrigerant charge or only check if there seemed to be a problem?	
Airflow	How did you measure airflow before the CoolSavers program? Did you always measure airflow or only measure when there was a problem? Did you change the air filter before the program? Do you change it when you perform a CoolSavers tune-up now?	

6. How much longer, if any, does the CoolSavers tune-up take compared to your standard tune-up?
7. Why is that?
8. Do you now use any of the techniques you learned from program tune-ups when performing non-program tune-ups? What techniques?
9. [If program tune-ups are different] Do you charge a different price for CoolSavers' tune-ups (probe: since you are offering more services?)
10. Does the tune-up protocol or the Optimizer provide other benefits relative to your typical tune up that enable you to upsell or diagnose and correct other system issues?

Informing Replacement Free-Ridership

1. When there was no rebate program, what % of HVAC systems installed were high efficiency?
2. Do you feel the program's training has improved your ability to convince customers of the benefits of high-efficiency systems?
3. According to program records, __% of your installations were 14-15 SEER, __% were 16 -17 SEER, and __% were 18+ SEER. If not for the program, what percent of your program installations would have haven 13 SEER? What percent would have been 14-15, 16-17, and 18+ SEER?

Efficiency	**With program/rebate**	**Without program/rebate**
13 SEER	0%	
14-15 SEER	[PRE-POPULATE]	
16 SEER	[PRE-POPULATE]	
18+ SEER:	[PRE-POPULATE]	
Total	**100%**	**100%**

4. In your opinion, what percentage of the time does Ameren's rebate cause a customer to purchase a more efficient system than they otherwise would have?
5. Has there been any change in the number of heat pumps you are installing now that you are a CoolSavers contractor?
6. Do you install a programmable thermostat as part of all new systems?
7. If yes, was that standard practice before the program as well?
8. If it was not, approximately what percent of the time did you install a programmable thermostat before CoolSavers? [**RECORD:** ____]

Past Participation

1. Did you participate in Ameren's previous HVAC program, CheckMe! Plus run by proctor engineering?
2. If yes, do you have any thoughts about differences between the two programs? (**PROBE**: perhaps the relative strengths and weaknesses of each?)

Panel Study Recruitment

As part of this study we are also asking a subset of participating HVAC contractors, as well as nonparticipating contractors, to provide a small sample of recent sales data on an annual basis for the next three years. If you are interested in this additional research, you will receive **$200** each time you submit sales data, which is a total of **$600** during the life of the study. We offer this incentive because we expect the study may take about an hour of your time each year. These data will help us understand trends in purchase practices using actual sales data from across Missouri. As with this interview, our

analysis and reporting is anonymous. Are you interested in learning more about this additional research?

[If Yes] Great! I'll have another member of my team reach out to you with more details shortly.

Wrap Up

Do you have any additional comments about the Ameren Missouri CoolSavers program?

DISTRIBUTOR INTERVIEW GUIDE

[**NOTE**: This interview guide is intended for HVAC distributor company managers that operate within Ameren Missouri's service territory.]

Hello, my name is _____ and I am calling on behalf of Ameren Missouri's CoolSavers Program. We are interested in whether you are aware of the program, as well as whether you've noticed changes in contractor or customer purchasing practices over the last few years. Anything you say in this interview is confidential and we will combine it with responses to similar questions provided by other distributors.

[**IF ASKED**: On average, the interview takes approximately 20 minutes. If this isn't a good time, I'd be happy to call you back at another time that works better for you.]

Researchable Questions:

- Have you heard about Ameren Missouri's CoolSavers program?
    - If yes, how did you hear about the program?
- Do you feel the program has increased the total number of units sold this year?
    - If yes, how so?
- Do you feel the program has impacted the contractors you work with? (probe: are there more contractors getting business in the area?)
    - If yes, how so?
- Approximately how many total split AC and heat pump units do you distribute annually?
- How many package units?
- Approximately how many split ACs and heat pumps do you distribute to contractors operating in Ameren, MO service territory? **Probe:** This includes the greater St. Louis area west to Jefferson City and north to the Iowa border, as well as southeast Missouri including Cape Girardeau **[REFER TO SERVICE TERRITORY MAP AS NEEDED]**?

- How have your stocking practices changed since 2009? For example, what was the distribution of high-efficiency units then compared to now? Focusing just on split systems, in 2009, how many were…

	PERCENT OF SALES/INVENTORY				
SEER	**2009**	**2010**	**2011**	**2012**	**2013**
13 SEER					
14-15 SEER					
16 SEER					
18+ SEER:					
Total	**100%**	**100%**	**100%**	**100%**	**100%**

- What do you think caused these changes?
- Are you familiar with Ameren's previous CheckMe! Plus HVAC program, which operated in 2010 and 2011?
- Did Ameren's previous CheckMe! Plus HVAC program or the current CoolSavers program have an impact on these changes? How so?
- What about pricing, has the Ameren CoolSavers program had an effect on how you price high-efficiency equipment in any way?
- Do you see manufacturer rebates piggy-backed on high-efficiency equipment that is eligible for Ameren Missouri rebates?
    - If yes, do you believe the manufacturer would have offered the rebate if not for the Ameren rebate?
    - If yes, do you believe the availability of the Ameren rebate impacted the amount of the manufacturer rebate? If so, how?
    - If no (to either question), why do you think manufacturers are not reacting to Ameren's rebate?
- To the best of your knowledge, what percentage of contractors that you sell to, participate in Ameren Missouri's program?
- From your perspective, what could Ameren do to improve the reach or effectiveness of the program?
- Have you actively promoted the program to your contractors?
    - If yes, what steps have you taken to promote the program? (hosted trainings, information in newsletters, etc.

Panel Study Recruitment

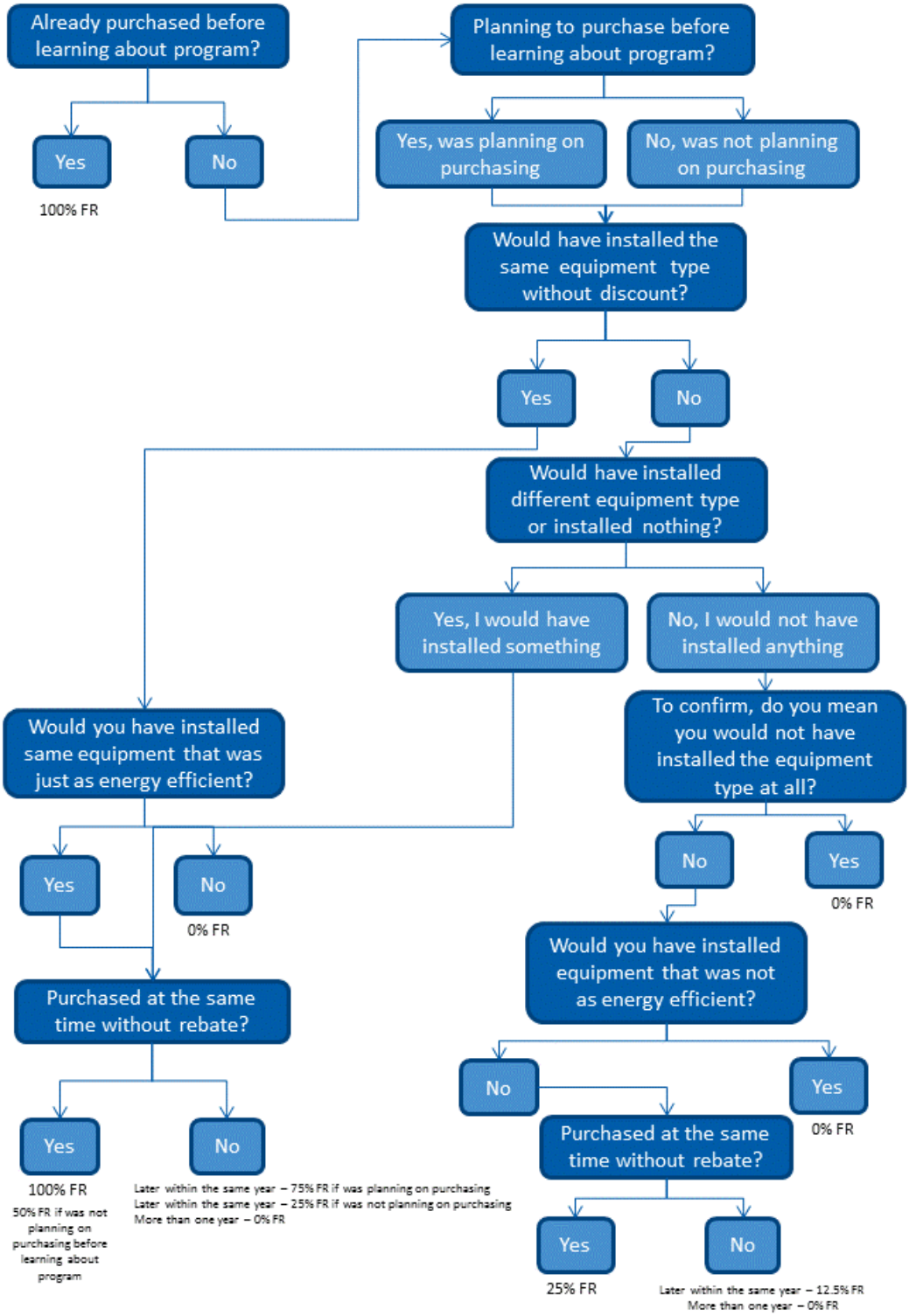
As part of this study we are also asking a subset of participating HVAC contractors, as well as nonparticipating contractors, to provide a sample of recent sales data on an annual basis for the next three years. We are also looking to enlist distributors such as you. If you are interested in this additional research, you will receive **$200** each time you submit a sample of sales data, which is a total of **$600** during the life of the study. We offer this incentive because we expect the study may take about an hour of your time each year. These data will help us understand trends in purchase practices using actual sales data from across Missouri. As with this interview, our analysis and reporting is anonymous. Are you interested in learning more about this additional research?

[If Yes] Great! I'll have another member of my team reach out to you with more details shortly.

Wrap Up

- Do you have any additional comments about the Ameren Missouri CoolSavers program?

APPENDIX E. FREE RIDERSHIP SCORING FLOW CHART

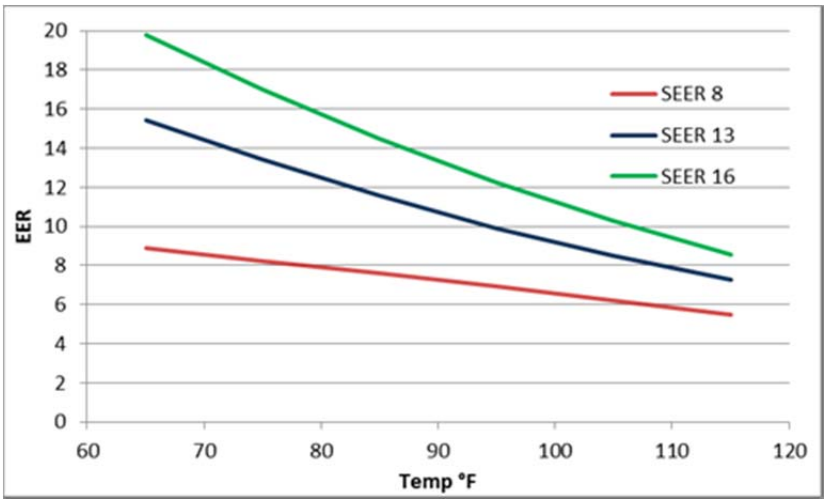


APPENDIX F. DETAILED ENGINEERING CALCULATIONS AND EXPLANATIONS

Early Replacement Baseline Efficiency

The CoolSavers tracking database includes SEER ratings of the replaced unit for new HVAC installation early replacement measures. It also includes the estimated age of the unit replaced. To following our savings methodology which calculates savings from meter data for every metered interval, we required a function that estimates EER at variable outdoor temperature. Manufacturer data does not reflect the actual performance of an existing, older unit so the team developed a new estimate of SEER to calculate early replacement savings. A baseline EER versus temperature curve was developed from the PY10 metering study which metered the actual EER versus outdoor temperature of 25 existing units. Figure 14 shows two examples of manufacturer's curves and another example of an average SEER 8 curve from PY10 meter data. The EER of the HVAC systems metered in PY10 is plotted versus outdoor temperature. The resulting curve is more linear than the EER versus temperature curves of high-efficiency systems.

Figure 14. Efficiency Curve Examples



Cadmus averaged contractor reported SEER values to establish an early replacement average SEER baseline.

We reviewed the SEER values reported by contractors to ensure we were using nameplate SEER ratings in all cases so that we could then apply a degradation factor uniformly to nameplate SEER values. We believed some reported SEER values were estimates that included an assumed degradation; others were guesses or were simply erroneous. We used the following rationale to adjust the reported SEER ratings:

- In 1992 the minimum required SEER rating was set to 10. Therefore the nameplate SEER rating of units sold from 1992 to 2006 should be no lower than 10. If a value in this range was less than 10 SEER we changed it to 10. If it was above 10 it was left unchanged based on the knowledge that units above the then federal minimum were sold.

- In 2006 the minimum required SEER rating was set to 13. Therefore any rating below 13 SEER for a unit sold after 2006 was set to 13. If it was above 13 it was left unchanged based on the knowledge that units above the then federal minimum were sold.

Prior to 1992 the consensus is the average is around 6 SEER.[30] Some contractors reported 10 SEER and we looked at these units specifically (there were only ~20) and changed the value to 6 SEER.

We then looked at degradation of efficiency by age. PY10 data had pre-tune-up data, nameplate efficiency, and equipment age for 3,900 units. These data allow us to calculate a degradation factor that includes age and maintenance related degradation. The average age of CoolSavers unit was 18.79 years and the average age of the systems replaced through the PY10 program was 19.2 years (in 2011)—very similar numbers. For CoolSavers the initial average recorded nameplate SEER was 9.49. After making the adjustments described above the average SEER rating rose to 9.80 (about 4% higher than recorded). The average nameplate SEER rating for CheckMe systems was 10.24.

The CheckMe program verified initial operating condition by testing the EER of the unit and correcting it to ARI conditions. The CoolSavers program did not verify initial operating conditions. We correlated the nameplate EER (also at ARI conditions) to test-in EER to determine efficiency degradation using the equation:

$$efficiency\ degradation\ \% = \frac{EER_{test-in}}{EER_{nameplate}}$$

To calculate early replacement baseline SEER values reported in the CoolSavers program we made the following assumptions:

- The % degradation of nameplate EER also represents the % degradation of nameplate SEER
- HVAC systems in the CheckMe and CoolSavers program have equivalent efficiency degradation per year of operation in Ameren's service territory

HVAC systems tested in the CheckMe program averaged degradation of 1.44% per year. Applying the CheckMe efficiency degradation to the CoolSavers SEER values resulted in a pre-tune-up SEER rating of 7.2 (see Table 38). We believe 7.2 SEER is a good representative estimate of the actual operating efficiency of the existing systems replaced through the CoolSavers program.

[30] http://www.consumerenergycenter.org/residential/heating_cooling/heating_cooling.html

Table 38. HVAC Program Reported Efficiency and Efficiency Degradation Factor

Parameter	CheckMe! Plus Program	CoolSavers Program
Average unit age	19.2	18.8
Average Nameplate SEER	10.2	9.8
Average Nameplate EER	8.8	Not available
Pre-tune up (degraded) EER	6.4	Not tested
Total degradation	27.6%	Calculated from PY10 data
Average annual degradation	1.44%`	Calculated from PY10 data
Extrapolated baseline operating SEER	NA	7.2 SEER

Tune-Up Data Collection Form—Optimizer

The tune-up data collection field for is shown in the following figures.

Contractor Information

Company Name:		Date:	
Technician's Name:		Technician Signature:	

Site Information

Customer Name:		Ameren Missouri Electric Account Number:		Address:	
		City:		Zip:	

System

House Information:	Approximate age:		Approximate Square Footage:		
	Basement:	Yes☐	No☐		
Type Of Installation:	AC only:	☐	Heat Pump	☐	
	AC and Electric Furnace:	☐	AC and Gas Furnace	☐	

Equipment

Outdoor:	Make:		Model:		Serial Number:	
Indoor Coil:	Make:		Model:		Serial Number:	
☐Furnace ☐ Air Handler					System Tons:	

Optimizer

Air Temperatures:	Outside Temperature F°	Thermostat Set Point F°	Below 65°	Check box if outside temperature is below 65° and a heat load was established inside the house to simulate a cooling load.
	75.0	72.0	☐	

Pre-Test Measurements and Results

External Static Pressure:	Supply (IWC)	Return (IWC)	Total ESP	Tons/Speed of Fan	System's nominal CFM:	1,200
	0.90	0.25	1.15	3 - High	BTUH's:	36,000
Calculated CFM:	810				Tons:	3
Coil Entering Conditions:	Dry Bulb	Wet Bulb	Qt	Relative Humidity		
	78.0	63.0	28.57	47%		
Coil Leaving Conditions:	Dry Bulb	Wet Bulb	Qt	Qt is Enthalpy in BTU/LB.		
	60.0	49.0	19.75			

Pre-Test Coil Capacity

Calculated CFM		Converts CFM into lbs/hr		Enthalpy (A minus B)	Coil Capacity BTUH
810	x	4.5	x	8.82	32,164

Pre-Test System Effective Efficiency

Present Coil Capacity BTUH	Divided by	Nominal Capacity	=	System Efficiency
32,164		36,000		89%

Pre-Test System WATTAGE

	Volts		Amps		Watts
Blower Motor:	120.0	x	6.0	=	720
Compressor:	220.0		14.0		3,080
Condenser Fan:	220.0		2.0		440
				Total System Watts	4,240

CADMUS

Tune Up Procedures

Changed or Cleaned air filter	☐ YES ☐ NO	
Adjust airflow	☐ YES ☐ NO	
Adjusted refrigerant charge	☐ YES ☐ NO	
Cleaned outdoor coil	☐ YES ☐ NO	
Cleaned indoor coil	☐ YES ☐ NO	
Check electrical system	☐ YES ☐ NO	
Check Thermostat	☐ YES ☐ NO	
Check and Clean Condensate Drain	☐ YES ☐ NO	
Check Refrigerant Lines	☐ YES ☐ NO	
Check Condenser Fan	☐ YES ☐ NO	
Clean blower compartment and fan blade	☐ YES ☐ NO	

Post-Test Measurements and Results

	Supply (IWC)	Return (IWC)	Total ESP	Tons/Speed of Fan		
External Static Pressure:	0.30	0.20	0.50	3.5 - Med-High	System's nominal CFM:	1,400
Calculated CFM:	1,268				BTUH's:	42,000
					Tons:	3.5
Coil Entering Conditions:	Dry Bulb	Wet Bulb	Qt-A	Relative Humidity		
	78.0	65.0	30.06	53%		
Coil Leaving Conditions:	Dry Bulb	Wet Bulb	Qt-B	Qt is Enthalpy in BTU/LB.		
	56.0	56.0	23.84			

Post-Test Coil Capacity

Calculated CFM		Converts CFM into lbs/hr		thalpy (QT-A minus QT-B	Coil Capacity BTUH
1,268	x	4.5	x	6.22	35,491

System Effective Efficiency

Present Coil Capacity BTUH	Divided by	Nominal Capacity	=	System Efficiency
35,491		36,000		99%

Post-Test System WATTAGE

	Volts		Amps		Watts
Blower Motor:	120.0	x	3.0	=	360
Compressor:	220.0		11.0		2,420
Condenser Fan:	220.0		1.0		220
				Total System Watts	3,000

Refrigeration Charge Verification

tdoor ambient temperature at unit:	85	°F DB	R410A	☐	R22	☐

Charge Data - Post Test

For TXV	Actual subcooling °F DB:		OEM subcooling goal °F DB:	
(Optional for Geothermal)	Subcooling deviation (subcooling - subcooling goal):	0	°F DB must be +/- 3°F of goal	
	Liquid Line pressure:		Lqiud Line Temperature:	
For Fixed Orifice	Actual superheat°F DB:		Target superheat °F DB:	
(Optional for Geothermal)	Superheat deviation (superheat goal - superheat):	0	°F DB must be +/- 5°F of goal	
	Suction Line pressure:		Suction Line Temperature:	

Charge Data - Refrigerant Charge Adjusted/Final

For TXV	Actual subcooling °F DB:		OEM subcooling goal °F DB:	
(Optional for Geothermal)	Subcooling deviation (subcooling - subcooling goal):	0	°F DB must be +/- 3°F of goal	
	Liquid Line pressure:		Lqiud Line Temperature:	
For Fixed Orifice	Actual superheat°F DB:		Target superheat °F DB:	
(Optional for Geothermal)	Superheat deviation (superheat goal - superheat):	0	°F DB must be +/- 5°F of goal	
	Suction Line pressure:		Suction Line Temperature:	

APPENDIX G. ADDITIONAL CONCLUSIONS

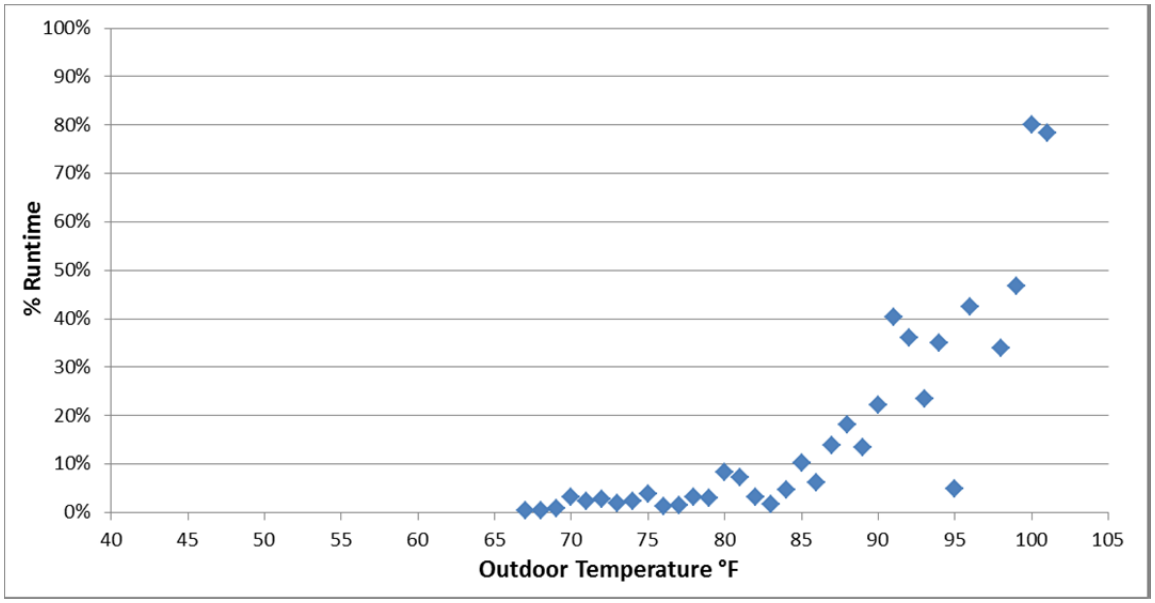
Based on the preceding findings, the Cadmus team presents the following additional CoolSavers conclusions. The primary conclusions and recommendations are located in the Executive Summary of this report.

Conclusion 10*:* New systems are installed correctly and using relatively low energy. Our evaluation found high-efficiency HVAC systems consume 1,892 kWh and that early replacement with a high-efficiency CoolSavers unit saves an average of 1,805 kWh. Our field work also determined that participating contractors correctly installed nearly all CoolSavers HVAC systems.

Conclusion 11: Over-sizing or improperly sizing is not an issue. Our data showed, on the average, participating contractors installed units through CoolSavers that were slightly smaller capacity than the replaced systems (from 3.3 to 3.1 tons). Whether this amount of down-sizing would increase energy savings is uncertain. Based on our experience, we offer the following observations about sizing:

- Manual J provides a methodology to size a system correctly and should lead customers to avoid overpaying for a unit that is larger than required while maintaining comfort. It is a useful tool for contractors but we do not believe requiring Manual J calculations would lead to increased savings and may cause contractors to not participate in the program.
- An over-sized system would likely short-cycle, for example, running 10 minutes instead of 20 minutes for a right-sized system. This can decrease overall efficiency and increase operating cost (although how much is not well studied). The findings from our analysis suggest that over-sizing is not a problem for CoolSavers. We reviewed the HVAC unit runtime during the peak demand (August 30th from 3-4pm) and found systems with a call for cooling were operating as expected during peak conditions – nearly continuously. Figure 15 shows an example of coincidence factor versus outdoor temperature for a new HVAC system.

Figure 15. Coincidence versus Outdoor Temperature



Review of the meter data of all newly installed HVAC sites indicates less than 20% of the systems metered could be over-sized (that is, they were not running as much as a properly-sized system runs when weather was at peak conditions). There are other factors to consider when using metered runtime during the peak demand period to assess system sizing. Considering these factors, some of the 20% that appeared over-sized might in fact be correctly sized. These factors include:

- User interaction (turning on or off down the thermostat during the peak period)
- The indoor and outdoor conditions assumed when calculating cooling load might differ from the actual conditions during the peak period.

Conclusion 12: Minor additions to the data collection requirement of the tune-up program will help the evaluation team interpret the data to provide future program design recommendations. The executive summary provides a recommendation (based on conclusion #6) suggesting contractors record the following:

- Does this system have an existing maintenance agreement?
- Did this customer sign up for a maintenance agreement?
- In your opinion should this HVAC system be replaced?

Analysis of NTG survey response showed HVAC systems on maintenance contracts had a free ridership score of 13% higher than those not on contracts. We also investigated the reported EER improvement from the Optimizer tool for the surveyed respondents. Table 39 shows a difference in savings between the systems on maintenance agreements but the sample size and associated precision is too small for this finding to be reliable.

Table 39. Comparison of the Efficiency Improvement of Tune-Up Systems on Maintenance Contracts

Existing Maintenance Agreement				
Sample Size	Pre EER	Post EER	% Efficiency Improvement	% HVAC Units Requiring Refrigerant Adjustment
17	10.74	11.09	3.3%	29%
No Existing Maintenance Agreement				
Sample Size	Pre EER	Post EER	% Efficiency Improvement	% HVAC Units Requiring Refrigerant Adjustment
23	10.80	12.04	11.5%	43%

In addition to tracking information about existing maintenance agreements, we provide an example of qualitative data that contractors could collect. If these data are collected, the team will gain a better understanding of the tune-up program impacts.

1. Rate condenser condition **prior** to service 1 to 5

   From a scale of 1-5 where 1= Very dirty (restricted airflow), 3=Medium dirty, 5= Very Clean (no airflow restriction)
   Cleaned? __ Yes __ No
   Fixed Bent fins? __ Yes __ No

2. Rate evaporator coil condition **prior** to service 1 to 5

   From a scale of 1-5 where 1= Very dirty (restricted airflow), 3=Medium dirty, 5= Very Clean (no airflow restriction)
   Cleaned? __ Yes __ No

3. Rate duct condition 1 to 5

   From a scale of 1-5 where 1= Very leaky, 3=Average leakage, 5= Minimal leakage
   Duct location description:_____

4. Est. remaining life of unit
   Drop-downs:
   Select (1-15) ___ Years
   Recommended replace? __ Yes __ No

Conclusion 13: The Cadmus team investigated various participant parameters including home square footage, system size, age of home and indoor temperature. Not surprisingly HVAC energy consumption and system size (tons) correlated as expected. Similarly, homes with lower indoor cooling temperature setpoints used more energy while homes with higher setpoints used less energy – both obvious and expected results. The other characteristics we investigated – home age and square footage, did not present any obvious correlation.

APPENDIX H.FREE RIDERSHIP SCORING TABLES

NEW HVAC INSTALLATION FREE RIDERSHIP SCORING TABLES

Table 40 illustrates how initial survey responses are translated into whether the response is "yes," "no," or "partially" indicative of free ridership (in parentheses).

Table 40. Raw Survey Responses Translation to Free ridership Scoring Matrix Terminology

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = Yes]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = Yes]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = Yes]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = No]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**
Yes (Yes)	Yes (Yes)	Yes (Yes)	I wanted the cheapest option available (Yes)	Not at all important (Yes)	Very important (No)	Not at all important (Yes)	Lower efficiency (No)	Sooner (Yes)
No (No)	No (No)	No (No)	I wanted the most efficient option possible (Yes)	Not very important (Partial)	Somewhat important (Partial)	Not very important (Partial)	Same efficiency (Yes)	At the same time (Yes)
Don't Know (Partial)	Don't Know (Partial)	Don't Know (Partial)	I researched my options and decided this was the right balance of efficiency and cost (Yes)	Somewhat important (Partial)	Not very important (Partial)	Somewhat important (Partial)	Higher efficiency (Yes)	Later in the same year (Partial)
Refused (Partial)	Refused (Partial)	Refused (Partial)	My contractor convinced me this was the right balance of efficiency and cost (No)	Very important (No)	Not at all important (Yes)	Very important (No)	Don't Know (Partial)	In one or two years (No)
			I heard Ameren provided an incentive for this SEER (No)	Don't Know (Partial)	Don't Know (Partial)	Don't Know (Partial)	Refused (Partial)	In three to five years (No)
			It's the same efficiency as my old unit (Yes)	Refused (Partial)	Refused (Partial)	Refused (Partial)		After more than 5 years? (No)
			I wanted something more efficient than my old unit (Yes)					Don't Know (Partial)
			Don't Know (Partial)					Refused (Partial)
			Refused (Partial)					

Table 41 shows how the string of responses from Table 40 is then translated into a free ridership score.

Table 41. Sample of Free ridership Scores

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**	**FR Score**
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Yes	100%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Partial	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Yes	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Partial	50%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Yes	75%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Partial	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Yes	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Partial	25%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Yes	25%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Yes	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	No	x	0%

Each participant free ridership score starts with 100%, which we decrement based on their responses to the nine questions as shown in Table 42.

Table 42. New HVAC Installation Free Ridership Scoring Legend

Q#	Decrement
FR1	50% decrement for "No," 25% decrement for "Partial"
FR2	50% decrement for "No," 25% decrement for "Partial"
FR3	25% decrement for "No," 25% decrement for "Partial"
FR4	50% decrement for "No," 25% decrement for "Partial"
FR5	50% decrement for "No," 25% decrement for "Partial"
FR6	50% decrement for "No," 25% decrement for "Partial"
FR7	50% decrement for "No," 25% decrement for "Partial"

Q#	Decrement
FR8	100% decrement for "No," 25% decrement for "Partial"
FR9	100% decrement for "No," 25% decrement for "Partial"

Below, we illustrate the unique response combinations from new HVAC installation applicants answering the CoolSavers free ridership survey questions (actual responses mapped to "yes," "no," or "partial," as indicative of free ridership); the free ridership score assigned to each combination; and the number of responses (see Table 43).

Table 43. Frequency of New HVAC Installation Free Ridership Scoring Combinations

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**	**FR Score**	**Count**
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Yes	75%	1
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Yes	12.5%	1
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Yes	12.5%	1
Yes	Yes	Yes	Yes	No	No	x	Yes	Yes	12.5%	1
Yes	Yes	Yes	No	No	No	x	Yes	Yes	0%	1
Partial	Yes	No	x	x	x	Partial	Yes	Yes	12.5%	2
Partial	Yes	No	x	x	x	Partial	Yes	No	0%	1
Partial	Yes	No	x	x	x	No	Yes	No	0%	1
Partial	Yes	No	x	x	x	No	Partial	Yes	0%	1
Yes	Yes	x	x	x	x	x	Yes	Yes	100%	4
Yes	Yes	x	x	x	x	x	No	x	0%	2
Partial	Partial	x	x	x	x	x	Yes	Yes	50%	5
Partial	Partial	x	x	x	x	x	Yes	Partial	25%	1
Partial	Partial	x	x	x	x	x	Yes	No	0%	2
Partial	Partial	x	x	x	x	x	Partial	Partial	12.5%	1
Partial	Partial	x	x	x	x	x	No	x	0%	5
Partial	No	x	x	x	x	Yes	Yes	Yes	25%	4
Partial	No	x	x	x	x	Yes	Yes	No	0%	1
Partial	No	x	x	x	x	Yes	No	x	0%	1
Partial	No	x	x	x	x	Partial	Yes	Yes	12.5%	9
Partial	No	x	x	x	x	No	Yes	Yes	0%	1
Partial	No	x	x	x	x	No	Yes	No	0%	1
Partial	No	x	x	x	x	No	Partial	Yes	0%	1
Partial	No	x	x	x	x	No	No	x	0%	2
No	Partial	x	x	x	x	x	Partial	Partial	0%	1
No	Yes	Yes	Yes	Partial	No	x	Yes	No	0%	1
Yes	Yes	No	x	x	x	Yes	Yes	Yes	50%	1
Yes	Yes	No	x	x	x	Partial	Yes	Yes	25%	2
Yes	Partial	x	x	x	x	x	Yes	Yes	75%	3
Yes	Partial	x	x	x	x	x	No	x	0%	1
Yes	No	x	x	x	x	Yes	Yes	Yes	50%	2
Yes	No	x	x	x	x	Yes	No	x	0%	1
Yes	No	x	x	x	x	Partial	Yes	Yes	25%	3
Yes	No	x	x	x	x	Partial	Yes	Partial	12.5%	1
Yes	No	x	x	x	x	Partial	Partial	Yes	12.5%	1
Yes	No	x	x	x	x	Partial	No	x	0%	1
Yes	No	x	x	x	x	No	Yes	Yes	12.5%	2
Yes	No	x	x	x	x	No	Partial	Yes	0%	1
Yes	No	x	x	x	x	No	No	x	0%	2
No	Yes	x	x	x	x	x	Yes	Yes	50%	2
x	Yes	x	x	x	x	x	Yes	Yes	100%	1
x	Partial	x	x	x	x	x	Yes	Partial	50%	1
x	No	x	x	x	x	No	No	x	0%	2

TUNE-UP FREE RIDERSHIP SCORING TABLES

Table 44 illustrates how initial survey responses are translated into whether the response is "yes," "no," or "partially" indicative of free ridership (in parentheses).

Table 44. Raw Survey Responses Translation to Free Ridership Scoring Matrix Terminology

F3. When you first heard of the Ameren discount, had you already scheduled your tune-up?	F4. To confirm, you scheduled the tune-up and then found out about the Ameren discount, is that correct?	F5. Did the contractor explain what was different about a CoolSavers tune-up from their standard tune-up?	F6. [IF F3=Yes] What did they say was different? [Check all that apply] 1Checked airflow 2.Checked/adjusted refrigerant charge 3. Cleaned indoor coil 4. Cleaned outdoor coil 5. Other	F7. If the $75 discount provided by Ameren had not been available, would you have still purchased the CoolSavers tune-up?	F8. Without the discount, would you have had the CoolSavers tune-up performed…? [READ LIST]
Yes (Yes)	Yes (No)	Yes (Yes)	1 Mention (Yes)	Yes, would have purchased CoolSavers tune-up (Yes)	Sooner (Yes)
No (No)	No (No)	No (No)	2 Mentions (Partial1)	No, would not have purchased the CoolSavers tune-up (No)	At the same time (Yes)
Don't Know (Partial)	Don't Know (Partial)	Explained there was no difference (No)	3 Mentions (Partial2)	Don't Know (Partial)	Later in the same year (Partial)
Refused (Partial)	Refused (Partial)	Don't Know (Partial)	4 Mentions (No)	Refused (Partial)	In one or two years (No)
		Refused (Partial)	5 Mentions (No)		In three to five years (No)
			Don't Know (Partial2)		Or would not have done at all? (No)
			Refused (Partial2)		Don't Know (Partial)
					Refused (Partial)

Table 45 shows how the string of responses from Table 44 is then translated into a free ridership score.

Table 45. Sample of Tune-Up Free Ridership Scores

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**	**FR Score**
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Yes	100%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Partial	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Yes	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Partial	50%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Yes	75%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Partial	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Yes	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Partial	25%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Yes	25%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Yes	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	No	x	0%

Each participant free ridership score starts with 100%, which we decrement based on the participant's responses to the nine questions as shown in Table 46.

Table 46. Tune-Up Free Ridership Scoring Legend

Q#	Decrement
FR1	0% decrement for "No," Partial level not needed
FR2	0% decrement for "No," Partial level not needed
FR3	0% decrement for "No," Partial level not needed
FR4	75% decrement for "No," 50% decrement for "Partial2," 25% decrement for "Partial1"
FR5	50% decrement for "No," 25% decrement for "Partial"
FR6	100% decrement for "No," 25% decrement for "Partial"

Below, we illustrate the unique response combinations from new HVAC installation applicants answering the CoolSavers free ridership survey questions (actual responses mapped to "yes," "no," or "partial," as indicative of free ridership); the initial free ridership score assigned to each combination; and the number of responses. The table does not reflect scoring adjustments that were made to respondents who received a refrigerant charge adjustment or airflow adjustment.

Table 47. Frequency of Tune-Up Free Ridership Scoring Combinations

F3. When you first heard of the Ameren discount, had you already scheduled your tune-up?	F4. To confirm, you scheduled the tune-up and then found out about the Ameren discount, is that correct?	F5. Did the contractor explain what was different about a CoolSavers tune-up from their standard tune-up?	F6. [IF F3=1] What did they say was different? [Check all that apply]	F7. If the $75 discount provided by Ameren had not been available, would you have still purchased the CoolSavers tune-up?	F8. Without the discount, would you have had the CoolSavers tune-up performed…? [READ LIST]	FR Score	Count
Yes	No	Yes	Yes	Yes	Yes	100%	5
Yes	No	Yes	Yes	Yes	Partial	75%	1
Yes	No	Yes	Yes	Yes	No	0%	1
Yes	No	Yes	Yes	Partial	Yes	75%	1
Yes	No	Yes	Yes	No	Yes	50%	1
Yes	No	Yes	Partial1	Yes	Yes	75%	1
Yes	No	Yes	Partial2	Yes	Yes	50%	6
Yes	No	Yes	Partial2	Yes	No	0%	1
Yes	No	Yes	Partial2	Partial	No	0%	1
Yes	No	Yes	Partial2	No	No	0%	1
Yes	No	No	x	Yes	Yes	100%	12
Yes	No	No	x	Yes	Partial	75.0%	1
Yes	No	No	x	Yes	No	0%	1
Yes	No	No	x	No	Partial	25%	1
Yes	No	No	x	No	No	0%	4
No	x	Yes	Yes	Yes	Yes	100%	1
No	x	Yes	Yes	Yes	Partial	75%	2
No	x	Yes	Yes	Partial	No	0%	1
No	x	Yes	Yes	No	No	0%	4
No	x	Yes	Partial1	No	No	0%	1
No	x	Yes	Partial2	Yes	Yes	50%	2
No	x	Yes	Partial2	No	No	0%	2
No	x	Yes	No	Yes	Yes	25%	1
No	x	No	x	Yes	Yes	100%	9
No	x	No	x	Yes	Partial	75%	3
No	x	No	x	Yes	No	0%	2
No	x	No	x	Partial	Yes	75%	1
No	x	No	x	Partial	Partial	50%	1
No	x	No	x	Partial	No	0%	2
No	x	No	x	No	Yes	50%	1
No	x	No	x	No	Partial	25%	2
No	x	No	x	No	No	0%	4